DRAFT
IN-SITU OXIDATION
TREATABILITY STUDY

REMEDIAL DESIGN

EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

RESPONSE ACTION CONTRACT (RAC), REGION I

For
U.S. Environmental Protection Agency

By
Tetra Tech NUS, Inc.

EPA Contract No. 68-W6-0045
EPA Work Assignment No. 119-RDRD-0189
TtNUS Project No. N4112

January 2003

TETRA TECH NUS, INC.

RI031005D

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1.0 INTRODUCTION

This report summarizes the results of the in-situ treatability study that was conducted at the Eastern Surplus Company Site (the Site) located in Meddybemps, Maine by Tetra Tech NUS, Inc. (TtNUS) on behalf of the U.S. Environmental Protection Agency (EPA). All work was performed to satisfy the requirements and the scope of work under Contract No. 68-W6-0045, Work Assignment (WA) No. 054-RDRD-0189 and WA No. 119-RDRD-0189. The scope of work presented in the Draft Final Work Plan, Revision No. 1 (April 2001) for WA No. 054-RDRD-0189 details the treatability study approach and proposed implementation. Some of the technical work has been modified based on discussions between the EPA Remedial Project Manager and TtNUS project personnel.

The scope of work consisted of two phases of sodium permanganate ($NaMnO_4$ or permanganate) additions; several groundwater sampling events, including before, during and after the permanganate additions; and measurement of general water quality parameters throughout the study. Other work performed to support the treatability study consisted of advancement of bedrock borings, borehole geophysics, installation of nested wells in selected bedrock borings, installation of small diameter wells in the overburden, pumping tests and tracer tests.

1.1 Objective

The objective of this in-situ treatability study was to evaluate the effectiveness of sodium permanganate decreasing the concentrations of volatile organic compounds (VOCs), primarily tetrachloroethene (PCE), in the surficial and bedrock aquifers at the Site.

1.2 Site Description

The Eastern Surplus Company Superfund Site is located in Meddybemps, Maine, in Washington County, which is generally located in the northeastern coastal portion of the state (Figure 1-1). The Site is approximately 70 miles east-northeast of Bangor, Maine, at a latitude of 45° 02' 20" north, and a longitude of 67° 21' 30" west. The Site is a 4- to 5-acre abandoned junkyard bounded by Meddybemps Lake to the north, by Mill Pond and the Dennys River to the

east, by Route 191 to the south, and by private property and Stone Road to the west (Figure 1-2).

The area enclosed by the perimeter chain link fence defines the Site. Currently, the Site is primarily open, with little vegetation. A large volume of hazardous materials and debris was removed through historical and more recent response actions by the state and federal government. During the Remedial Investigation (RI) activities, the majority of the remaining junk materials and debris scattered on approximately 30 percent of the Site were removed. In July 1999, contaminated soils within the contaminated groundwater plume areas were also removed as part of the non-time-critical removal action (NTCRA).

The eastern boundary of the Site slopes steeply to Mill Pond, the uppermost portion of Dennys River. Erosion of the slope was evident, and runoff and entrained soils discharged to Mill Pond and the Dennys River. These slope areas have been stabilized as part of the NTCRA.

The Dennys River originates at Meddybemps Lake in Meddybemps, Maine, and flows approximately 20 miles to Cobscook Bay and the Atlantic Ocean. A dam adjacent to the northern portion of the Site controls flow from the lake into the head of the Dennys River (Mill Pond). A concrete hydroelectric structure straddles the Dennys River about 500 feet downstream from the dam, adjacent to the southern portion of the Site. A small wetland, estimated to encompass approximately 2,585 square feet has been identified adjacent to the northeastern portion of the Site, just downstream of the dam.

The Site was a former surplus and salvage operation that operated from approximately 1946 until 1976. During that time, numerous hazardous materials and chemicals were brought to and stored on Site, including drums and cans containing solvents; calcium carbide, compressed gas cylinders, electrical transformers, capacitors, and old ammunition. The Site was also occupied by numerous defunct equipment, machinery, and vehicles. The EPA, the Maine Department of Environmental Protection (MEDEP), and the U. S. Department of Defense (DOD) performed several removal actions from 1985 through 1990. With the incorporation of the Site to the National Priorities List (NPL) in 1996, a RI was subsequently completed to delineate the extent of contamination, identify potential contaminant migration pathways, and to assess potential risks to human health and to the environment.

The Final Remedial Investigation Report, Eastern Surplus Company Site, Meddybemps, Maine (TtNUS, July 1999) provides detailed Site background information and history, descriptions of the physical features and demographics, descriptions of Site hydrogeology and geology, evaluations of environmental contamination, and assessment of human health risks. Additional hydrogeologic evaluations are presented in several U.S. Geological Survey (USGS) reports that are appended to the RI report. The Eastern Surplus Superfund Site Ecological Risk Assessment (Roy F. Weston, July 1999) evaluates the potential for adverse ecological risks associated with releases of hazardous chemicals from the Site. Preliminary descriptions of Native American cultural resources discovered at the Site are presented in the Results of the Phase I and Phase II Archaeological Testing of the Eastern Surplus Company Superfund Site, Meddybemps, Washington County, Maine (Archaeological Research Consultants, Inc., 2000).

A synopsis of the Site characteristics and contamination in the environmental media are presented in the September 2000 Record of Decision (ROD).

1.3 Summary of Events Leading to the Treatability Study

Groundwater samples were collected during the RI (from 1996 through 1998) to assess the contaminants that could be present in the aquifer as the result of past waste disposal or releases at the Site, or through offsite migration. Groundwater samples were collected from these areas of the aquifer: upgradient, northern and southern plumes, non-plume and plume areas. Detailed descriptions of the sampling, laboratory analysis, and analytical results are presented in two reports: the Remedial Investigation Groundwater Sampling Summary Report (Roy F. Weston, Inc. 1999) and the Remedial Investigation Report (TtNUS, July 1999). Since 1999, additional groundwater samples have been collected to further assess the presence of groundwater contamination in the bedrock aquifer; the results were presented in two reports: June 1999 Sampling – Data Summary Report (TtNUS, August 1999) and the Supplemental Bedrock Investigation Report (TtNUS, March 2000).

The principal goal of the 1999 NTCRA, a groundwater response action, was to address the contaminants identified in the shallow bedrock aquifer. Low concentrations of VOCs were also detected in some of the deep bedrock boreholes during 1999, which were evaluated by TtNUS during 2000 under the Phase 1 treatability study.

A Feasibility Study (FS) was completed in 1999 that identified options to address the remaining groundwater contamination issues. The FS identified in-situ chemical oxidation and enhanced flushing as two methods that could result in achievement of the remedial action objectives more quickly than groundwater extraction and treatment or natural attenuation.

A ROD was issued in September 2000 that identified the selected long-term remedy for the Site. The remedy complements the previous response actions (both time-critical and non-time-critical), which resulted in removal of all contaminated soils that posed threats to human health and groundwater quality, and the removal of hazardous materials in drums, cylinders, and other containers from the Site. As the result of the 1999 NTCRA and the other previous actions, groundwater is the only remaining contaminated environmental medium that requires remedial action.

All identified hazardous materials, contaminated soils containing chemicals in excess of the NTCRA action levels, and debris have been removed and sent to a licensed offsite waste disposal facility as part of EPA's response actions during 1998 and 1999. Also, in 1999, the Site was graded, stabilized and re-vegetated. Currently, the Site is occupied by the groundwater treatment plant, two extraction well systems, and an infiltration gallery to recharge treated groundwater.

Because of the dynamic nature of groundwater, and as a result of the contaminated soil removal during the 1999 NTCRA and the in-situ chemical oxidation treatability studies, the chemical composition of the northern and southern groundwater plumes has been altered since the completion of the RI in 1999. Since 1999, the northern and southern groundwater plumes are being remediated using pump and treat technology.

1.4 Report Organization

The following sections of this report summarize the methods used for data acquisition, the results of the study, conclusions, and recommendations.

Section 2 documents the treatability study activities and investigation methods; Section 3 presents a revised conceptual site model; and Section 4 presents the results and evaluation of

the data for the northern and southern VOC plume areas; Section 5 presents the summary and conclusions; Section 6 presents recommendations; and Section 7 lists references for this report.

2.0 PHASE I AND II IN-SITU CHEMICAL OXIDATION TREATABILITY STUDY

This section summarizes the activities conducted to support and implement the treatability study.

The treatability study was divided into two treatability study phases. The objective of Phase I was to conduct a treatability study to evaluate whether chemical oxidants could be effectively delivered into the water-bearing fractures in the bedrock aquifer within the most contaminated portions of the contaminant plumes, and whether PCE concentrations could be decreased. The heterogeneous nature of the bedrock fractures and the low permeability of some of the fracture sets made it difficult to estimate how effective the chemical oxidation could be. While in-situ oxidation has been employed at various sites for remediation, these had all been contaminated overburden aquifers or unsaturated soils. Delivery and distribution of the oxidizer in a relatively homogenous aquifer material are more implementable than in a fractured bedrock environment. The Phase I test results provided crucial empirical information in determining whether in-situ chemical oxidation was viable for the Eastern Surplus Company Site and whether an expanded Phase II test would be implemented.

The Phase II treatability study objective was to further evaluate the effectiveness of in-situ chemical oxidation in decreasing groundwater PCE concentrations in the northern and southern plumes to below remediation goals (drinking water standards). The Phase II treatability study consisted of continued application of sodium permanganate into the northern plume on a more widespread basis, and varying how permanganate would be applied. As a supplement to the in-situ oxidation tests, enhanced flushing tests were performed to assess whether altering the groundwater flow through the bedrock aquifer could stimulate PCE removal.

2.1 Borehole Drilling and Well Completion

Bedrock wells were installed and sampled during the year 2000 to support the in-situ treatability study. Additional bedrock wells were installed from February through April 2001 to support the full-scale design of the northern extraction system. These wells were developed and sampled in March and April 2001, and in June 2001. Results of the March-April 2001 and June 2001 sampling events were used to evaluate the effect of in-situ oxidation and the extent of contamination.

All new and existing geologic logs and well completion diagrams are provided in Appendix A. Well completion details are summarized on Table 2-1.

2.1.1 Extraction and Addition Wells

In preparation for the Phase I in-situ treatability study, overburden and bedrock wells were completed in the vicinity of the northern and southern plume areas. The purpose of these additional wells was to focus the addition of the oxidant (sodium permanganate) in the core of each plume. After completing the treatability study, more wells were installed to support the long-term addition of chemical oxidant and monitoring, and the final design of the extraction and treatment systems.

Each of the bedrock wells were advanced using a conventional air-rotary drill rig equipped with 6- and 8-inch diameter downhole air hammer drill bits. Initially, each borehole was advanced using the 8-inch bit approximately 2 feet into the top of bedrock to install a temporary 6-inch ID steel casing to prevent overburden materials from entering the borehole during drilling and well completion. During advancement of each bedrock borehole, a TtNUS geologist noted the rate of advancement, description of soil and rock cuttings, and other observations such as odor and sheen, if present. After reaching a predetermined total depth, each borehole was developed by blowing air through the drill bit until the discharge water was free of sediment. If a borehole did not yield a sufficient amount of water then water was added from the drill rig. Water from the Dennys River was used for this purpose.

Each of the extraction wells was completed with 4-inch ID Schedule 40 PVC casing and v-wound or machine-slotted well screen with 0.010-inch openings. The location of the well screen was predetermined based on the location of water yielding fractures identified from borehole geophysical logging. In order to avoid potential clogging of water-bearing fractures, the well screen in the bedrock portion of the borehole was installed without sand pack opposite of the well screen. A silicon shale trap was positioned on the well screen at the bedrock socket and sand pack was added opposite the overburden portion of the well screen and extended 1 to 2 feet above the top of screen. Bentonite was installed above the sand pack to seal the annulus surrounding the well casing to approximately 5 feet below ground surface. Soil cuttings were used to backfill the remaining 5 feet to ground surface in anticipation that this material will be

excavated at a later date for installation of a manhole for connecting the extraction well to the treatment system.

Nested (upper and lower) bedrock monitoring wells were installed in selected boreholes located in the northern plume. These nested wells were constructed of 1.25-inch Schedule 40 PVC casing and machine slotted well screen with 0.010-inch openings. The location of the well screens were based on the location of water-yielding fractures determined from borehole geophysical logging. Sand pack was placed opposite and a few feet above both well screens, and bentonite seals were installed above and below the sand pack to prevent cross connection between the two nested wells. Each well was developed with a Waterra surge block until free of sediment. Upper and lower wells in nested wells are identified with a "1" and "2", respectively, in the suffix of the well identifier.

Overburden boreholes were advanced using a conventional drill rig equipped with 4-inch or 6-inch inner diameter (ID) casing. Soil samples were collected using a split-spoon sampler (2-inch or 3-inch ID by 24 inch long), and blow counts recorded for every 6-inches the sampler was advanced to measure the material density. Monitoring wells were installed in selected borings. Each well consisted of 2-inch ID Schedule 40 PVC well casing and machine slotted screen with 0.010-inch openings. Well development was conducted by pumping and surging until the discharge was free of sediment.

2.1.1.1 Northern Plume Wells

Prior to performing the Phase I treatability study, two oxidant addition wells (IN-1B, IN-2B) were installed to a depth of 100 feet in the upper fractured bedrock in the core of the plume. In addition, two overburden wells (MW-42SB, MW-44SB) were installed to the top of bedrock and two bedrock wells (MW-39B, MW-40B) were installed 200 feet into the bedrock to better delineate the extent of potential VOC contamination. Inflatable packers were installed in MW-39B and MW-40B to isolate the upper and lower portions of each borehole for evaluation of vertical gradients and extent of VOCs at these two locations.

In support of full-scale design, six wells (MW-41S, MW-42S, MW-43S, MW-44S, MW-45S, MW-46S) were completed in the overburden; four open-hole bedrock monitoring wells (MW-41B, 42B, 43B) were completed to a depth of 200 feet in the bedrock; one deep (200 ft.)

extraction well (RW-8) was added downgradient of the core of the plume; and three shallow (overburden-bedrock interface) extraction wells (RW-9, -10, -11) were added to augment the northern plume NTCRA extraction system. In addition, four potential injection wells (IW-1 through IW-4) were added upgradient of the northern plume to enhance the flushing of the plume to the extraction wells. Subsequently, 1.25-inch ID wells were nested in open-hole bedrock wells (MW-41B, 42B, 43B). This preliminary full-scale extraction system consisting of nine extraction wells (RW-2, -3, -4, -8, -9, -10, -11, MW-39B, and MW-40B) was piped to a temporary treatment system and the effluent was piped to the four injection wells and tested. The total extraction rate from this test was approximately 8 gallons per minute (gpm) extraction and 8 gpm injection.

Based on the information developed to date, it was determined that MW-35B should be converted into an extraction well. This extraction well would be used to accelerate removal of PCE mass located in the core of the plume. In general, areas of highest PCE concentration (or mass) are the areas that take the longest to attenuate. Use of MW-35B as an extraction well should help reduce the time for the highest concentration area to achieve clean up.

The yield of each well was initially assumed during modeling based on the Site hydrogeology. After the potential set of extraction wells was installed, the actual well yield was measured during the single well pumping tests described below. The total flow rate for the northern system (10 extraction wells) was estimated as 8 gpm.

2.1.1.2 Southern Plume Wells

In support of the Phase I treatability study, two overburden chemical addition wells (IS-1S, IS-2S) were installed to the top of bedrock and two bedrock permanganate addition wells (IS-1B, IS-2B) were installed to a depth of 100 feet in the upper fractured bedrock. Similar to the northern plume, these wells were installed in the core of the plume.

In support of full-scale design, four small-diameter wells (MW-47S, MW-48S, MW-49S, MW-50S) were completed in the overburden to complement the existing network of monitoring wells between the southern plume extraction system and the Dennys River.

2.1.2 Direct Push Permanganate Addition Wells

Small-diameter wells were advanced using direct push technology (DPT) along separate grids positioned across the northern and southern plumes for potential long-term addition of chemical oxidants. All points were constructed with ¾-inch ID PVC pipe with 2 feet of machine slotted well screen with 0.010 inch openings. Permanent monitoring wells MW-47S, -48S, -49S and -50S were installed using DPT. The depth of each small-diameter well is summarized on Table 2-2.

2.1.3 Infiltration Gallery Monitoring Wells

Two sets of well couplets (IG-1S/1D, IG-2S/2D) were installed immediately downgradient of the infiltration gallery to monitor potential head buildup in the gravel pack surrounding the drains and in the surficial aquifer in the immediate vicinity of the infiltration gallery. Each couplet consisted of a shallow well with a 2 foot long screen in the gravel pack and a deeper well with a 10 feet screen across the water table. All wells were constructed of 2-inch ID Schedule 40 PVC and machine-slotted screen with 0.010-inch openings.

2.2 Borehole Geophysics

All geophysical logging was performed by Northeast Geophysical Services (NGS) of Bangor, Maine, a subcontractor under the direction of TtNUS. Geophysical logging (caliper, gamma, flowmeter, acoustical televiewer), was performed during the week of June 5, 2000 in six newly drilled bedrock boreholes: MW-39B, MW-40B, IN-1B, IN-2B, IS-1B and IS-2B. A second geophysical logging event was performed by NGS in March and April 2001 in nine newly drilled bedrock boreholes: MW-41B, MW-42B, MW-43B, RW-8, IW-1, IW-2, IW-3, IW-4 and the Smith Well. In addition, fluid temperature and fluid resistivity logs were included in boreholes MW-41B, MW-42B, MW-43B, RW-8 and the Smith Well.

The first geophysical survey of the Site was performed by the USGS and documented in "Characteristics of Fractures in Crystalline Bedrock Determined by Surface and Borehole Geophysical Surveys, Eastern Surplus Superfund Site, Meddybemps, Maine" (Hansen and Others, 1999). In addition, per request of the EPA, the USGS performed borehole geophysical

logging of bedrock wells (MW-27B, MW-28B, MW-29B, RW-3, RW-4, RW-7) in support of the NTCRA treatability study.

Based on review of USGS borehole logs for the Site and consultation with NGS, subsequent geophysical logging consisted of caliper, natural gamma, flowmeter and acoustical televiewer. In addition, per request of the Maine DEP, fluid resistivity and temperature logging was performed in selected wells (MW-41B, MW-42B, MW-43B, RW-8, Smith Well).

The objective of geophysical logging was to identify the location and relative transmissivity of water-bearing fractures, their orientation, and to differentiate between the Meddybemps granite and the gabbro-diorite intrusive complex, which are the rock formations previously mapped in the area of the Site. In addition, flowmeter logging was performed at certain wells during operation of the northern extraction system which provided data indicating interconnection of shallow and deep water-bearing fractures.

The caliper log indicates possible fractures in each borehole. The flowmeter measurements, which were taken under ambient and pumping conditions, indicate the transmissive fractures in each borehole. The acoustical televiewer (ATV) log shows the dip angle and dip direction of identified features (fractures) in each borehole. The gamma log is useful at this Site to distinguish between different rock types. In general, the gamma count rate in the boreholes was 5 counts per second (cps) or less. These areas of low count rate are interpreted to be gabbro. There are some areas in the boreholes where the gamma count rate exceeded 10 cps. These areas of relatively high count rates are interpreted as granite or commingled gabbro and granite. Fluid temperature and resistivity can sometimes locate transmissive fractures.

The NGS geophysical logs are provided in Appendix B.

2.3 Well Survey and Groundwater Level Measurements

TtNUS subcontracted a Maine-licensed surveyor, OEST Associates of South Portland, Maine, in June 2001 to survey new wells and stake small-diameter wells for permanganate addition at the Site. OEST surveyed the location and elevation relative to the state plane coordinate system and National Geodetic Vertical Datum of 1929, respectively. Subsequent to the OEST survey, manholes were installed at the new extraction wells (MW-35B, MW-39B, MW-40B, RW-8,

RW-9, RW-10, RW-11) causing the elevation in these wells to change. TtNUS resurveyed these wells and MW-46S to MW-50S relative to existing wells. Elevation data for existing wells are summarized in Table 2-1.

The depth to groundwater was measured at the start of groundwater sampling events and at other times to draw groundwater contours and estimate capture zones during testing of the NTCRA and full-scale extraction system. In addition, water levels were measured during testing of the full-scale extraction system while treated water was added to four bedrock wells (IW-1 to IW-4) located upgradient of the northern plume.

2.4 Extraction System Drawdown Testing

Four pumping tests were conducted to support the final design of the northern plume extraction system, maintain capture, and enhance recirculation. The first three tests were performed in the northern plume for evaluation of the final design, and the fourth test was performed to confirm that the NTCRA system was adequate for full-scale design.

2.4.1 Drawdown Test No. 1

The first test was a constant-rate drawdown test of MW-39B and MW-40B while the NTCRA extraction wells (RW-2, -3, -4) were operating. The test was started on January 31, 2001 at 5 pm. Each well was equipped with a pneumatic submersible pump. The pumping rate was approximately 2.6 gpm for the NTCRA groundwater extraction system (RW-2, 3, 4). MW-39B and MW-40B each yielded approximately 0.3 gpm. The test was terminated after sufficient data was collected to identify the number and locations of additional deep extraction wells for further testing for full-scale design. The results of this pumping test are presented in Appendix C.

2.4.2 Drawdown Test No. 2

The second drawdown test included the NTCRA interim extraction system (RW-2, -3, -4), MW-39B, MW-40B, and newly installed wells RW-8, -9, -10, and –11. After several days of pumping to provide sufficient time for the groundwater system to reach equilibrium, a synoptic round of water levels was conducted on June 22, 2001. Each well was equipped with a pneumatic submersible pump. The combined pumping rate for wells RW-2, RW-3, RW-4, RW-8, RW-9,

RW-10, RW-11, MW-39B, and MW-40B was approximately 8 gpm. The results of this pumping test are presented in Appendix C.

2.4.3 Drawdown Test No. 3

The third drawdown test consisted of operating the same extraction wells used during the second test, except the well discharge was treated with granulated activated carbon, and the treated water was added to IW-1 to IW-4 located upgradient of the VOC plume. After several days of pumping to provide sufficient time for the groundwater system to reach equilibrium, a synoptic round of water levels was conducted on June 14, 2001. All of the treated effluent was added to IW-1, -2, -3, and -4. The total flow rate during this test was approximately 8 gpm. The results of this pumping test are presented in Appendix C.

2.4.4 Drawdown Test No. 4

The fourth drawdown test consisted of a constant-rate pumping test of the southern plume extraction wells (RWS-1, -3, -5, -6, -7) operated together. After several days of pumping to provide sufficient time for the groundwater system to reach equilibrium, a synoptic round of water levels was conducted on June 11, 2001. The total combined flow was approximately 12 gpm. The results of this test are presented in Appendix C.

2.5 Tracer Tests

Two tracer tests were performed in the northern VOC plume area of the Site. The purpose of the testing was to evaluate the interconnection of fractures in the shallow and deep bedrock and to evaluate the effectiveness of capture of a preliminary full-scale extraction-injection well system. Conservative (non-reactive) inorganic tracers, chloride (Cl^-) and bromide (Br^-), were selected. A description of the tracer test methodology and results are presented in Appendix D.

2.6 Phase I and II Permanganate Additions

The effectiveness of insitu chemical oxidation depends on three factors: the kinetics of the reaction between the sodium permanganate and the contaminant; the contact between the oxidant and the contaminant(s); and competitive reactions of permanganate with other

reduced/oxidizable species. If the contaminant being targeted for in-situ oxidation is reactive (i.e., chlorinated ethenes), and sufficient oxidant is added to overcome the demand from other reduced species, the limiting factor to the successful application of in-situ oxidation is the transport of the oxidant to the areas of contamination, and not the reaction itself between the permanganate and the contaminant. The oxidation of TCE and PCE by permanganate is, compared to the time to transport the permanganate to the treatment zone, an essentially instantaneous reaction. If the permanganate contacts the contaminant, it will react. Significant oxidation can be observed in as little as a few hours after addition. By contrast, travel times for the permanganate to migrate away from the addition point may be on the order of days to weeks, depending on the rate of groundwater flow.

The most common sources of permanganate include potassium permanganate or sodium permanganate. Potassium permanganate is purchased as a dark purple solid crystalline material, which is placed into a liquid solution (generally 1 to 2 percent). This solution is purple in color that is visible down to low (> 0.25 mg/l) concentrations. Potassium permanganate is readily available in a granular crystalline form through many chemical supply companies and is relatively inexpensive (approximately $1.50 per pound). Sodium permanganate is purchased in liquid form, at a 40 percent concentration suitable for direct addition, or dilution and addition. Although more expensive than potassium permanganate, sodium permanganate (approximately $6.75 per pound) is available at a much higher concentration, decreasing the volume of liquid to be added, and less field time is required for mixing and handling. Either potassium or sodium permanganate is effective in oxidizing chlorinated ethenes, petroleum hydrocarbons, simple polynuclear aromatic hydrocarbons (PAHs), ketones, ethers and alcohols.

Oxidation in the geologic environment may cause precipitation of some metals (i.e., iron, manganese, and copper) and may mobilize others (i.e., chromium, selenium, uranium, and molybdenum). The most common of these metals is chromium, naturally occurring or anthropogenic. Application of any oxidant can oxidize the trivalent chromium species to more soluble and toxic hexavalent chromium species. Metal analyses are typically performed initially and during testing to determine any potential concerns for metal mobilization due to oxidation treatment.

Permanganate cleaves the carbon double bond of PCE (C_2Cl_4), yielding carbon dioxide, manganese dioxide, and ions of hydrogen, sodium and chloride.

The complete balanced equation for reaction of sodium permanganate and PCE follows:

$$4NaMnO_4 + 3C_2Cl_4 + 4H_2O \rightarrow 6CO_2 + 4MnO_2 + 4Na^+ + 12Cl^- + 8H^+$$

The stochiometry of the equation indicates four moles per liter of sodium permanganate is required to oxidize three moles per liter of PCE. Other materials that are oxidized by permanganate include natural organic carbon and reduced inorganic compounds. Of the inorganics, reduced forms of iron (Fe) and manganese (Mn) may consume a significant portion of the oxidant. Permanganate oxidation produces particles of manganese dioxide (MnO_2), which have the potential to decrease the effective porosity of the aquifer.

While the $NaMnO_4$: PCE ratio is important for determining the minimum amount of this oxidant required to oxidize the mass of PCE at a site, in practice, a ratio of 10:1 is applied in an attempt to overcome the natural oxidation demand.

Because the mass of organic contaminants in the aquifer is uncertain, one of the goals of the Phase I treatability study was to better estimate the amount of oxidant required to remediate contamination to below cleanup goals during subsequent additions. Another goal of the treatability studies was to evaluate the effectiveness of the addition method to deliver the permanganate to the PCE in the northern and southern plumes.

During Phase I, permanganate additions were directed at wells located in the core of both the northern and southern plumes while the extraction systems were inactive to increase the contact time between the permanganate and the VOCs. Each phase consisted of the addition of variable concentrations of sodium permanganate to selected wells and monitoring of field parameters in selected wells downgradient of the addition wells. The results of the Phase I study were used to establish the delivery method and volume of permanganate necessary to remediate the northern PCE plume in the upper bedrock aquifer.

In Phase II, a grid was established for installation of small-diameter wells in both the northern and southern plumes. The locations of the small diameter wells may differ from those shown on Figure 2-1, due to access constraints. Permanganate was added under 30-40 psi pressure into small-diameter wells in the northern plume with the goal of promoting infiltration of permanganate into the upper bedrock. Because VOC concentrations were low, permanganate

was not added to the southern plume. As a contingency, small-diameter wells were installed for future uses if necessary, to reduce VOC concentrations.

After the initial Phase I addition, the southern extraction system was activated and the groundwater was stored temporarily in a 21,000 gallon capacity frac tank. EPA requested the extracted groundwater with dissolved permanganate be re-used at the Site. The Phase I test was enhanced by "recirculating" the water with dissolved permanganate from the southern frac tank into upgradient monitoring wells in both the northern and southern VOC plumes. The recirculation enhancement plan started on August 8, 2000. The following subsections provide additional details of the permanganate additions.

2.6.1 Northern VOC Plume

A summary of Phase I and II permanganate additions to the northern VOC plume and general observations are presented in Tables 2-3 and 2-4, respectively. The quantities of permanganate added during Phase I and II are summarized in Tables 2-5 and 2-6, respectively.

2.6.1.1 Phase I Permanganate Additions

In Phase I, a total of three addition events were conducted, where $NaMnO_4$ was added to selected wells located in the core of the northern plume.

First Addition

On July 18, 2000, 20 percent permanganate was initially added (2 gallons per well) to two bedrock wells (MW-34B1, MW-35B). These two wells were chosen because they are located in the core of the northern VOC plume. After allowing two days for the permanganate to migrate, on July 20, 2000, permanganate was added (2 gallons per well) to two bedrock wells (IN-1B, IN-2B) located midway downgradient from the two initial addition wells and upgradient from the NTCRA extraction wells (RW-2, -3, -4).

A total of 8 gallons of 20 percent sodium permanganate was added to the northern plume in the bedrock aquifer. This amount was three times the stochiometric amount based on a mass calculation of the northern plume. Three times the stochiometric amount was added, instead of

10 times the amount, as a precaution to avoid potential impacts on the Dennys River, which is a State of Maine Class AA river and designated Atlantic Salmon spawning area.

After the initial permanganate addition, permanganate was observed in a southern extraction well that caused activation of RWS-5 to effect capture and prevent permanganate migration to the Dennys River. Groundwater pumped from RWS-5 contained unspent permanganate which was discharged to a 20,000 gallon frac tank. This water was sampled and determined to contain 30 mg/L permanganate. On August 8, 2000 the groundwater containing 30 mg/L of permanganate was added to a bedrock well (MW-20B at 1.5 gpm) located in the former area of maximum PCE concentrations in soil, and to two bedrock wells (MW-28B at 1 gpm, MW-29B at 0.25 gpm) located upgradient of the two initial addition wells (MW-34B1, MW-35B). The addition rates for the wells varied according to the rate each well would take water to avoid potential overtopping of the wells. This rate of addition was maintained until August 11, 2000, when addition to these wells was terminated.

The northern extraction system was activated on August 16, 2000 to promote oxidation of VOCs between the upgradient addition wells and the extraction wells. The extraction system continued to operate until August 22, 2000 (6 days total).

On August 18, 2000, the remaining 30 mg/L permanganate water from the southern frac tank was added as a slug to one overburden well (MW-3S received 20 gallons), and to two bedrock wells (MW-3B received 20 gallons and MW-24B received 45 gallons).

On August 22, 2000, approximately 30 gallons of groundwater containing permanganate was added to MW-34B, and IN-2B from RW-3 and RW-4, respectively. On the following day (August 23, 2000), approximately 66 gallons of permanganate-laden groundwater was added to MW-34B, and IN-2B from RW-3 and RW-4, respectively. One day later (August 24, 2000), permanganate laden groundwater extracted from RW-3 and RW-4 was added to MW-34B (90 gallons), and IN-2B (150 gallons), respectively.

Extraction well RW-4 was activated on August 25, 2000,and pumping continued for 6 days, until September 1, 2000, in an effort to promote migration of permanganate in IN-2B toward RW-4.

Permanganate remained in the addition wells MW-34B, MW-35B, IN-2B, and MW-24B through August 31, when it was purged from the wells to prepare these wells for the Post-Phase I VOC sampling event (September 5-9, 2000).

Other engineering factors (permanganate concentration, volume added, and delivery method) also affected the migration of permanganate in the fractured bedrock in the northern plume. Because permanganate solution is denser than water, when the delivery method is by direct pour in the top of the well, the permanganate will dissolve as it descends to the bottom of well. If the application interval extends into bedrock that is of low permeability relative to the upper-most bedrock and it accumulates in the bottom of the well, then the amount of permanganate available for oxidation is limited primarily to diffusion into the water column, with limited advection and volatilization in the boring. In the case of MW-34B, groundwater flow is upward (0.03 to 0.05 gpm) under ambient conditions; in contrast, groundwater flow in MW-35B is downward (0.03 to 0.13 gpm) under ambient conditions. At the newly installed northern bedrock wells, IN-1B and IN-2B, the direction and magnitude of flow was immeasurable (less than 0.01 gpm) under ambient conditions. Because geophysics indicated groundwater exits MW-35B at approximately 90 to 105 feet below ground surface (bgs), a single-packer was installed in this borehole to isolate the upper zone from the deeper zone. At MW-35B, permanganate was added to the upper zone to minimize potential loss through the lower zone.

Second Addition

Groundwater samples collected in early September 2000, after the initial permanganate addition indicated PCE concentrations were elevated, as high as 16,000 ug/L (6 percent of PCE solubility) at MW-35B1. On September 22, 2000, 20 percent permanganate was added to MW-20B (3 gallons), MW-34B1 (0.5 gallons), MW-35B (4 gallons), IN-1B (1 gallon) and IN-2B (0.5 gallons). In addition, because an elevated PCE concentration was detected in MW-3B (12,000 µg/L) in May 2000, a one-time dose of permanganate (2 gallons) was added to this well.

Third Addition

Groundwater samples collected in November and December 2000 indicated PCE concentrations increased in November 2000, as high as 22,000 ug/L (9 percent of PCE solubility) at MW-34B1, then dropped back down in December 2000 to levels found between

June 2000 (before the initial addition) and September 2000 (after the initial addition). In January 2001, 40 percent permanganate was added to the same "second addition" wells in increased quantities, as follows: MW-20B (4 gallons), MW-34B1 (6 gallons), MW-35B1 (8.5 gallons), MW-35B2 (8.5 gallons), IN-1B (4 gallon) and IN-2B (4 gallons). This is equivalent to approximately 53 kg of permanganate. The permanganate additions were followed by hot/warm water to fill the casing and provide some hydraulic head to push the permanganate into the bedrock fractures. Hot water was added to prevent freezing of the water column and to facilitate the possible benefit of increasing the water temperature to potentially improve the rate of the oxidation reaction.

2.6.1.2 Phase II Permanganate Additions

Post-Phase I groundwater sampling (September, November, December 2000) showed elevated PCE concentrations, a factor of two or more higher than pre-Phase I additions, indicating additional permanganate was needed to overcome the oxidation demand of the aquifer. Phase II was planned to be a more widespread application and it was thought that installation of a grid of wells drilled to the top of bedrock would promote infiltration of permanganate into the upper bedrock fractures.

On April 30, 2001, the installation of 0.75 inch ID direct push (DP) wells began, installed in a grid beginning with the northern most row (N1) (Figure 2-1).

During Phase II, groundwater from the northern recovery system was pumped into a 20,000 gallon frac tank, then through a particle filter and two GAC drums, before reapplying the water to wells IW-1B through IW-4B, located upgradient of the northern plume. This was done to increase recirculation and distribution of permanganate into the fractured bedrock. Field parameters (pH, temperature specific conductance oxidation-reduction potential (ORP), turbidity, dissolved oxygen, color, and depth to groundwater) were measured prior to, during and 1 week after Phase II additions, over a 4-week period.

On May 1, 2001, sodium permanganate additions started at the northernmost row and progressed to downgradient rows, through May 13, 2001. Sodium permanganate was added followed by pressurized water (30-40 psi), to 60 of the 73 DP wells over a 3-week period (April 30 – May 20, 2001). The permanganate added to the wells was initially a 5 percent

concentration (May 1 to May 10, 2001) and was subsequently decreased to 2 percent (May 14, 2001) and finally to 1 percent (May 15 through 17, 2001). The volume added to each well was determined from the concentration of PCE in groundwater within 15 feet of each DP point, as shown on iso-concentration maps. Water was added to each DP well, immediately after permanganate addition, to promote migration of the permanganate into the formation. A total of approximately 1,440 gallons of 1 to 5 percent sodium permanganate solution was added to the DP wells.

On May 9, 2000, permanganate was observed in the discharge from the recovery wells and RW-2, identified as the well intercepting permanganate dissolved in groundwater. No other significant changes were noted in the field parameters measured in groundwater sampled collected from bedrock wells. Additional DP wells were installed at the midpoints between selected rows located in the core of the PCE plume.

On May 16, 2000, pink permanganate was observed in RW-11. Throughout the fourth week of the Phase II program (May 21-27, 2001), recovery wells were monitored for color and no permanganate was observed. On May 23-24th, all DP wells in rows N1 through N4 were flushed with water.

2.6.2 Southern VOC Plume

The Phase I permanganate additions for the southern VOC plume are discussed below. Permanganate addition wells and general observations are summarized in Table 2-7. The amount of permanganate applied is summarized in Table 2-8. It is noted that because VOC concentrations were low in the southern plume after Phase I, permanganate was not added during Phase II.

2.6.2.1 Phase I Permanganate Additions

A total of 25 gallons of 20 percent sodium permanganate was added to the southern plume: 14 gallons added to the overburden and 11 gallons added to the bedrock. This amount was three times the stochiometric amount based on a mass calculation of the southern plume. Three times the stochiometric amount was added, instead of 10 times the amount, as a precaution to avoid potential impacts on the Dennys River.

Permanganate was added initially (July 18, 2000) into three overburden wells (MW-8S, MW-33S, IS-2S), two bedrock wells (MW-8B, IS-2B), and into a recovery well (RWS-6). These wells were chosen because they are located in the core of the southern VOC plume. Two days after the initial addition, permanganate was observed in a bedrock well (IS-1B) located downgradient from extraction wells, and the closest extraction well (RWS-5) was activated (2 gpm) the same day.

Addition to an upgradient overburden well (IS-2S at 2.5 to 3 gpm) was started on July 24 2000, and a second extraction well (RWS-3 at 2.5 gpm) was added the same day. The next day (July 25th), two upgradient overburden wells MW-18S (1.5 gpm) and MW-33S were activated, and pumping at RWS-5 was stopped overnight to conserve storage in the southern frac tank. The following day (July 26, 2000), pumping continued at RWS-5 (1.5 gpm) and RWS-6 (2 gpm), and permanganate addition continued to MW-18S (1.5 gpm) from RWS-5.

Pumping and addition continued at RWS-5 and MW-18S, respectively, through August 8th, and also started adding 30 mg/L permanganate groundwater from the southern frac tank to MW-9S (2 gpm). In addition, a sump pump was placed in the southern frac tank that contained water with 30 mg/L of permanganate. The tank was connected to the main discharge line to continue using the permanganate remaining in storage. Pumping of RWS-5 and adding to both MW-9S and MW-18S continued through August 15th. On August 15th, started adding to MW-22B (1 gpm) from southern tank. Continued pumping RWS-5, and adding to MW-9S, MW-18S, MW-22B, and MW-25S through August 17th. On August 17th, RWS-6 replaced RWS-5 and addition stopped at MW-9S and MW-22B when the frac tank was dewatered. On August 18th, pumping was stopped at RWS-3, and addition was stopped at MW-18S and MW-25S. Pumping continued at RWS-6 through August 23rd. On August 23rd, RWS-6 was replaced by RWS-5, which continued pumping through the Post-Phase I sampling program (September 5-9, 2000). Also, permanganate-laden groundwater pumped from RWS-6 was added to IS-2B (two well columns – August 22nd), MW-8S (one well column – August 24th), IS-2B (one well column – August 24th).

On August 29, 2000 and 30th, IS-2B was purged of purple permanganate water in preparation for the post-Phase I groundwater sampling event.

2.6.2.2 Phase II Permanganate Additions

Because southern plume groundwater VOC concentrations were low no Phase II additions of permanganate were required for the southern plume. As a contingency, DP wells were installed on a grid if future permanganate additional are required to reduce potential high VOC concentrations.

2.7 Groundwater Sampling and Analysis

This section summarizes groundwater sampling and analysis methods used before and after the Phase I and II permanganate additions.

2.7.1 Pre-Phase I Groundwater Sampling

After completion of the drilling program, a groundwater sampling round was conducted. The objective of this sampling event was to measure baseline VOC concentrations in groundwater prior to starting the Phase I Treatability study. Groundwater samples were collected from a representative set of overburden and bedrock wells located throughout both the northern and southern VOC plumes.

April-May 2000 - Samples were collected following EPA's low flow ("low stress") sampling procedure and submitted for VOC and total metals analysis.

2.7.2 *Phase I Groundwater Sampling*

Groundwater field parameters were measured in northern and southern VOC plume wells daily, both prior to (baseline) and after the addition of permanganate. The parameters measured were depth to groundwater, color, temperature, ORP, pH, specific conductance, turbidity, and dissolved oxygen.

Prior to the start of the Phase I groundwater sampling, TtNUS evaluated various methods to neutralize residual sodium permanganate that may be present in wells. This was necessary since the presence of residual permanganate in groundwater samples would likely continue to oxidize any VOCs in the groundwater sample, and the analytical results would likely be biased

low or produce false negatives, thus incorrectly indicating successful aquifer treatment. After consultation with Carus Chemical, the sodium permanganate manufacturer, and review of EPA drinking water analytical methods, sodium thiosulfate was selected as an appropriate neutralizer. All groundwater samples collected for VOC analysis at the Site were first neutralized with sodium thiosulfate so as to eliminate residual permanganate presence.

September 2000 – In early September 2000, groundwater samples were collected from the following monitoring wells: IN-1B and 2B, IS-1B and 2B, IS-1S, IS-2S, MW-3B, MW-8B, MW-8S, MW-18S, MW-20B, MW-22B, MW-23B, MW23-S, MW-30S, MW-31S, MW-33S, MW-34B, MW-35B1, MW-35B2, MW-36B1 and -B2, MW-44S, RW-2, RW-3, RW-5, RW-7B and -B2, RWS-3, RWS-4, RWS-5, RWS-6, and RWS-7). All samples were collected using EPA's low flow ("low stress") sampling procedure and submitted for VOC analysis.

December 2000 - A comprehensive groundwater sampling event was completed in early December 2000. All groundwater monitoring wells were sampled (unless dry) using EPA's low flow ("low stress") sampling procedure and sent for VOC analysis.

2.7.3 Phase II Groundwater Sampling

Groundwater field parameters were measured in northern and southern VOC plume wells daily both prior to (baseline) and after the addition of permanganate. The parameters measured were depth to groundwater, color, temperature, ORP, pH, specific conductance, turbidity, and dissolved oxygen.

March-April 2001 - Groundwater samples were collected from the following monitoring wells (IN-1B, IN-2B, IS-1S, IS-1B, MW-4B, MW-8B, MW-8S, MW-20B, MW-31S MW-34B1 and –B2, MW-35B1 and B2, MW36B1 and B2, MW-39B, MW-40B, RW-3, RW-4, RW-5, RW-7B1, RWS-4, RWS-5, RWS-6) during mid March 2001. Samples were collected following the EPA's low-flow sampling procedure and sent for VOCs analyses.

June 2001 – A comprehensive groundwater sampling event was completed during mid-June 2001. All groundwater monitoring wells were sampled (unless dry) using EPA's low-flow sampling procedure and sent for VOCs analyses.

November 2001– A comprehensive groundwater-sampling event was undertaken in early November 2001. All groundwater monitoring wells were sampled (unless dry) using EPA's low-flow sampling procedure and sent for VOCs and total metals analyses.

3.0 CONCEPTUAL SITE MODEL

This section presents the current conceptual model for the Eastern Surplus Company Site. Included in this section are summaries of the Site geology and hydrogeology, and the nature and extent of VOCs and metals contamination in groundwater at the Site.

3.1 Surficial Geology

Figure 3-1 shows a plan for the Site including the locations of wells and geologic cross-sections. Figure 3-2 shows cross-section AA' aligned approximately perpendicular to groundwater flow and through the line of extraction wells in the northern plume. Figure 3-3 shows cross-section BB' aligned through the southern plume line of extraction wells. Both sections serve to illustrate the geology, saturated thickness under non-pumping and pumping conditions, and the extent of the PCE concentrations in June 2001.

The glacial outwash deposit of coarse-grained sand and gravel (subaqueous fan), located along Stone Road, grades to coarse to medium sand beneath the central and southern portions of the Site. These deposits range in thickness from 0 to 14 feet, overlie bedrock or glacial till, and appear to extend to the Dennys River. As shown on Figure 3-2, the subaqueous fan pinches out against glacial till in the northern portion of the Site. Glacial till or till-like deposits consist of an unsorted mixture of pebbles, cobbles and boulders in a finer grained matrix of sand and silt. Boulders are common along the top of glacial till at a depth ranging from 11 to 14 feet below ground surface (bgs). The thickness of glacial till ranges from 0 to 15 feet on the west side of the Dennys River, increasing to 40 feet on the east side. Glacial till may be absent along the Dennys River.

As shown by both cross-sections, finer-grained glaciomarine deposits (Presumpscot Formation) overlie glacial till and coarse-grained subaqueous sand and gravel. These deposits consist of mostly silt with lesser fine sand and clay. The thickness of these fine-grained deposits ranges from 0 feet along the western margin of the Site to 20 feet in the southern portion. In addition, a discontinuous boulder/cobble zone occurs in some areas beneath the Site. This unit may be part of glacial till or fractured bedrock and extend east of the Dennys River to monitoring well MW-16B.

The natural surficial deposits are overlain by fill in some areas of the Site. The fill consists of silty sand and gravel. The thickness of fill ranges from 0 to 20 feet. During the NTCRA, fill was placed in excavations in both the northern and southern portions of the Site. Both areas are north of Route 191. In both locations, the excavation extended to the top of rock. The total depth of excavation ranged from 0 to 10 ft in the northern area, and from 0 to 20 feet in the southern area.

3.2 Bedrock Geology

Overburden deposits are underlain by igneous crystalline bedrock. A contour map of the bedrock surface is shown on Figure 3-4. The contours indicate the bedrock slopes generally from north to south and from west to east into a broad valley east of the Dennys River. Under non-pumping conditions, groundwater flow in the overburden generally follows the slope of the bedrock surface until it reaches the Dennys River, a groundwater discharge area. Bedrock surface elevations on the west side of the Dennys River are generally 10 to 20 feet lower than the bedrock surface on the east side.

Regional mapping of the bedrock (Ludman and Hill, 1990) indicated the bedrock in the vicinity of the Site consists of two igneous rock formations: the Gabbro-diorite intrusive complex and the Meddybemps Granite. The Meddybemps Granite is light-colored, medium-grained, plutonic igneous rock that consists of quartz, plagioclase feldpsar, potassium feldspar, biotite, amphibole, apatite, zircon and opaque minerals. The Gabbro-diorite intrusive complex consists of fine to medium-grained gabbro, diorite and gabbro-diorite. Gabbro is black to salt-and-pepper colored and consists primarily of plagioclase, hornblende, biotite, augite, orthoclase, apatite, zircon, sphene, epidote and opaque minerals.

3.2.1 Regional Bedrock Mapping

According to regional bedrock mapping (Ludman and Hill, 1990), the Gabbro-diorite intrusive complex is delineated generally as an oval shaped body in plan view with the western margin along Stone Road, with margins that extend approximately 0.5 miles from the Site to the north, south and east. The Meddybemps granite is mapped west of Stone Road and beyond the margin of the Gabbro-diorite complex. The regional delineation is generally consistent with geologic and borehole geophysical logs for the Site, with the exception that equigranular and

foliated diorite occurs beneath the overburden in the central portion of the Site in the vicinity of the infiltration gallery (former wells G1 through G-5), and in the northern portion, near the Dennys River (RW-1). Meddybemps granite and/or diorite intrusions into the Gabbro-diorite complex were noted in boring and/or geophysical logs at wells located in the northern portion of the Site (RW-3, RW-5, RW-8, MW-39B, MW-40B, MW-41B, MW-42B, MW-43B, IN-1B, IN-2B, IW-1, IW-3, IW-4).

Meddybemps Granite was not encountered in boreholes in the southern plume area of the Site, where boreholes generally penetrated less than 100 feet of bedrock. The deepest borehole in the vicinity of the Site is located immediately east of the Dennys River and north of Route 191 (Smith Well). A geophysical log of this well indicated possible granite from 244 to 421 feet (end of borehole).

3.2.2 Regional Bedrock Deformation Events

Slickensides, sheared and polished surfaces, which are evidence of brittle fracturing, occur in rock outcrops throughout the Calais Quadrangle (Ludman and Hill 1990). High-angle faults that strike both north and northwest are mapped within 10 miles of the Site. The nearest fault to the Site, shown on the Bedrock Map of the Calais Quadrangle (Ludman and Hill, 1980), trends northwest-southeast and is inferred about 1 mile northeast of the Site. To the north of Route 191, the Dennys River is oriented northeast-southwest, and the River is oriented northwest-southeast to the south of Route 191. The orientation of the River may be influenced locally by the bedrock structure. Felsic and mafic plutons in the Calais quadrangle, including the Meddybemps Granite and the Gabbro-diorite intrusive complex, have undergone three episodes of deformation (identified as D4, D5 and D6). These three deformation events were superimposed on earlier recumbent folding and faulting (Ludman and Hill, 1980).

The D4 deformation was synchronous with emplacement of gabbros, and north-trending, high-angle normal faults are associated with this deformation. The D4 faults are recognized by: the local development of cataclastic fabrics in narrow zones aligned within 10 degrees of north-south; similarly domainal close-spaced cleavage striking north and dipping steeply to vertically; small-scale north-trending upright folds; and local disruption of earlier structures (Ludman and Hill 1990). North-striking high-angle faults are mapped 7 to 10 miles northwest of the Site; they are part of the Princeton-Crawford fault zone, which forms the boundary between the

Fredericton trough and the St. Croix belt. In the adjacent Big Lake quadrangle, D4 faults were located by their topographic expression of valleys and aligned depressions oriented north-south.

The next episode of deformation, (D5), is associated with several northeast and north trending, strike-slip faults and the ENE-trending segment of the South Princeton-Crawford fault zone. Cataclastic fabrics and silicified zones were developed in the metasedimentary rocks and granites, and chloritized and/or serpentinized zones in the mafic rocks. Slickensides and small drag folds show mostly dextral strike-slip movement. An important exception was along the South Princeton-Crawford fault zone, approximately 7 to 10 miles northwest of the Site where earlier (D4) displacement was dominantly dip-slip, but reactivated later (D5) as a sinistral strike-slip offset.

Northwest and west-northwest trending shear zones are associated with the next episode of deformation (D6). Pluton contacts were offset in the eastern portion of the Calais quadrangle. Shear zones are commonly silicified and contain quartz veins. Subhorizontal slickensides and vertically plunging Z-shaped drag folds indicate sinistral strike-slip separation of these faults. Sinistral kinks were also observed. Northwest-striking faults occur between 1 and 7 miles northeast of the Site.

The last deformation of bedrock in the area resulted from removal of the weight of the continental ice sheet which created low-angle fractures parallel or subparallel to the bedrock surface. These fractures are referred to as unroofing joints (Lyford and others, 1999).

3.2.3 Site Bedrock Fractures

Geologic and borehole geophysical logs indicate the upper few feet of bedrock are weathered, broken and contain unroofing joints.

Orientations of open fractures in water-yielding zones were compiled from ATV borehole logs. A total of 893 fracture dip angles and dip directions from 19 boreholes (IN-1B, IN-2B, IS-1S, IS-2S, IW-1, IW-2, IW-3, IW-4, MW-34B, MW-35B, MW-36B, MW-27B, MW-39B, MW-40B, MW-41B, MW42B, MW-43B, RW-8, Smith Well) were selected as suspected water-bearing fractures. The dip angles and dip directions of these fractures were organized in a spreadsheet and imported into a computer program, GEOrient (version 8), to generate rose diagrams and

stereonets. Rose diagrams show the direction of fracture dip and stereonets plot the dip angle and dip direction for each pole to fracture plane as a point. Each point represents a line perpendicular to a fracture plane that intersects the lower-hemisphere. The poles are plotted as symbols and line contours according to the point density.

Composite Plots

Figure 3-5 shows rose diagrams and equal area stereonets at individual boreholes. Table 3-1 summarizes the preferred and secondary fracture strike and dip directions at individual boreholes in the northern and southern plume areas. The fracture orientations are summarized in the sections below for each of these plume areas.

As shown by the composite rose diagram the dip directions of 893 potential water-bearing fractures were distributed in similar numbers (+/- 45 degrees) to the north, south and west. Slightly higher numbers of fractures dip north-northwest and west-southwest.

The composite equal-area stereonet depicts the three-dimensional orientation of the dip and dip direction of 893 water-bearing fractures. The stereonet indicates most fractures are low-to-moderate-angle that dip northwest and strike southwest (equivalent to northeast).

Northern Plume Area

Table 3-1 indicates most fractures upgradient of the former contaminant source are moderate-to-high-angle (34 to 90 degrees) that dip southwest to south-southwest and strike northeast to west-northwest. Downgradient of the source most fractures are moderate-angle that dip northwest and strike northeast. Less frequent fractures dip to the northwest and southeast. Low-angle (0-33 degrees) fractures generally dip west-northwest and strike north-northeast; and moderate-to-high-angle fractures dip north-northeast and strike east-northeast or dip southwest and strike northwest.

Southern Plume Area

In the southern plume area, as indicated by Table 3-1, most fractures upgradient of the former source area are moderate-angle that dip east and strike north. Downgradient of the former source, most fractures are low-to-moderate-angle that dip west-northwest and strike north-northeast. Less frequent fractures dip to the northwest, west, southeast, south-southeast, and to the south-southwest. A few high-angle (60-90 degrees) fractures dip to the north-northwest and strike north-northeast.

The USGS performed surface and borehole geophysical surveys (Hansen and others, 1999) in the vicinity of the southern plume area. USGS studies indicated bbedrock fractures are oriented in three primary directions:

- a low-angle set that dip west-northwest and strike north-northeast;
- a high-angle set that dip east-southeast and strike north-northeast; and
- a second high-angle set that dip south-southeast and strike east-northeast.

East of Dennys River

A total of five boreholes located east of the Dennys river were geophysically logged. As Table 3-1 indicates, several fracture directions were observed. Most are moderate-to-high-angle fractures that dip north-northeast and strike west-northwest. Low-angle fractures dip northwest and strike northeast. Low-to-moderate angle fractures also dip northwest to west and strike northeast to north. Some high-angle fractures dip south-southwest and strike west-northwest.

3.3 Site Hydrogeology and Baseline Extent of Tetrachloroethene

The site hydrogeology is characterized by the presence of groundwater in a thin surficial aquifer underlain by a discontinuous aquitard and a fractured bedrock aquifer.

3.3.1 Northern Plume Area

Surficial Aquifer - The sand and gravel fill acts as a limited surficial aquifer, with a saturated thickness ranging from 0 to 5 feet. The direction of bulk groundwater flow is to the southeast,

toward the Dennys River discharge area. Monitoring wells completed in the surficial aquifer transmit less than 0.5 gpm when they contain water. Several monitoring wells completed in the surficial aquifer (MW-5S, -6S, -20S) are dry most of the year except after significant recharge events. While the northern extraction system is operating the overburden is dewatered.

Aquitard - The silt/fine sand and glacial till units act as an aquitard due to their fine-grained characteristics. The hydraulic conductivity of the glacial till varies from 0.1 to 1.0 feet/day (Lyford and others, 1999). The aquitard is discontinuous.

Bedrock Aquifer – In bedrock, groundwater is transmitted through interconnected, open fractures. The upper few feet is highly fractured and interconnected. With increasing depth, the density of interconnected fractures decreases. The groundwater flow directions are expected to vary in individual water-bearing fractures, depending upon their orientation; however, the direction of bulk groundwater flow in the upper bedrock is to the southeast toward the Dennys River. Transmissivity measured in this aquifer ranged from 66 ft^2/day (RW-5) to 224 ft^2/day (RW-3), and storativity ranged from 1.6E-03 to 2.25E-03 (TtNUS, 1999). The short-term yield from bedrock wells varies from less than 0.1 to 12 gpm (MW-35B) in the northern area of the Site.

The orientation of water-bearing fractures (dip and dip direction) is summarized below:

Upgradient of Former Source Area:

- IW-1B – Most groundwater transmitted through a moderate-angle fracture that dips south.
- IW-2B – Most groundwater transmitted through four low-to-high-angle fractures that dip south or southwest.
- IW-3B – Most groundwater transmitted through a high-angle fracture that dips east-northeast; two low-angle fractures that dip north-northwest; and a horizontal fracture.
- IW-4B – Most groundwater transmitted through a moderate-angle fracture and a high-angle fracture that dip north or north-northeast.
- MW-29B – Most groundwater transmitted through low-to- moderate-angle fractures that dip south-southwest.

Former Source Area:

- MW-34B – While RW-2, -3, and -4 are pumping, most water enters through a low-angle fracture at 61 feet below top of casing (btoc) that dips east-northeast, and exits through fractures at 13 to19 feet btoc. The dip of fractures at 16 and 19 feet btoc was measured: one low angle fracture dips west, and two moderate-angle fractures dip southwest.

- MW-35B – While RW-2, -3 and –4 are pumping, most water enters through a moderate-angle fracture at 9.5 feet btoc that dips east-northeast; a moderate-angle fracture at 13 feet btoc that dips northwest; two high-angle fractures at 15 feet btoc that dip west; and five moderate-angle fractures that dip northwest. Most water exits below 90 feet, primarily at 106 feet. While the dip of the fracture at 106 feet could not be measured, numerous fractures occur in this interval. Seven fractures are low-or-high angle that dip southwest; one low-angle fracture dips northwest and the remaining fracture in this interval is horizontal. This lower zone was sealed off, and the upper zone from 7 to 67 feet bgs was completed as an extraction well.

Downgradient of Former Source Area:

- IN-1B – Most groundwater is transmitted through a low-angle fracture at 107 feet btoc that dips east-northeast. Potential water-bearing fractures are present at 14 and 18 feet btoc that could not be measured.

- IN-2B – Most groundwater is transmitted through fractures at 12-18 feet btoc and 31-34 feet btoc. One low-angle fracture at 18 feet btoc dips north-northwest and seven moderate-angle fractures at 31-34 feet dip north-northwest.

- RW-7 – Most groundwater enters through a high-angle fracture that dips east. A small amount of water enters through a low-angle fracture at 85-88 feet btoc that dips north, and a moderate-angle fracture at 101 feet btoc that also dips north.

- MW-41B – Flowmeter measurements were variable, indicating this borehole was influenced by operation of the extraction system (RW-2, -3, -4, MW-39B, and -40B).

- MW-42B – Most groundwater enters though low-to-moderate-angle fractures at 18 to 32 feet btoc that dip southeast to south-southeast, and exits through a moderate-angle fracture at 63.5 feet that dips south, and a high-angle fracture at 118 feet that dips south-southwest.

- MW-43B – Most groundwater enters at 18 to 25 feet btoc, but the dip of fractures could not be measured. Most water exits at a low-angle fracture at 104 feet btoc that dips northwest.

Downgradient Extraction Wells:

- RW-3 – most groundwater enters at 14-16.8 feet btoc, but the dip could not be measured. A small amount of groundwater enters through a moderate-angle fracture at 21.5 feet that dips south-southeast.

- RW-4 – Most groundwater enters at 13.6 to 15 feet btoc, but the dip could not be measured.

- RW-8 – Most groundwater enters at 20 to 23 feet btoc, but the dip could not be measured. Some groundwater enters through two moderate-angle fractures at 43 to 53 feet that dip southwest.

- MW-39B – Most groundwater enters through a high-angle fracture at 66 feet btoc that dips east-northeast, a moderate-angle fracture at 99 to 100 feet btoc that dips south-southwest, and five moderate-to-high angle fractures at 134 to 138 feet btoc with three dipping northwest, one dipping west, and the remaining fracture dipping southwest.

- MW-40B – Most groundwater transmitted through moderate-to-high angle fractures at 52 to 57 feet btoc that dip west-southwest and one high-angle fracture at 139-144 feet btoc that dips southeast. Some groundwater may be transmitted through four low-to-moderate-angle fractures at 116 to 123 feet that dip northwest.

Summary of Water-Bearing Fracture Dip and Dip Direction

Upgradient of the former source area, borings IW-1B, -2B, and MW-29B intersected low-to high-angle fractures that dip south to southwest; IW-3B and IW-4B intersected low and high angle fractures that dip east-northeast to north-northwest.

In the former source area, fractures in boring MW-34B are influenced by pumping at RW-2, -3 and –4. Boring MW-35B was converted to an extraction well from 7 to 67 feet bgs. Most groundwater is transmitted from 9.5 to 15 feet btoc through moderate- and high-angle fractures that dip east-northeast, northwest and east-west.

Downgradient of the former source area, IN-1B, -2B, MW-43B and RW-7 intersect low transmissive fractures. MW-41B is influenced by operation of extraction wells RW-2, -3, -4, -8, MW-39B and MW-40B.

At downgradient extraction wells, most groundwater was transmitted through the upper few feet of fractured rock below the casing. While the fracture dip could not be measured in these shallow fractures, drawdown and tracer testing indicated extraction wells RW-2, -3, -4, -8, -9, -10, and –11 intersect water-bearing fractures that are connected to upgradient wells MW-34B and MW-35B in the former source area and IW-1B to IW-4B upgradient of the source area.

This information indicates that water-bearing fractures in the northern plume are interconnected. This was important for selection of wells for permanganate addition because it was necessary to add permanganate to wells that were hydraulically connected to the VOC plume. Also, this information established that the upgradient (IW-series) wells could be used as potential injection wells to increase the number of pore volumes (enhanced recirculation) in the fractured bedrock. The fracture data, along with the drawdown testing and tracer test data, established that the water-bearing fractures in the northern plume are hydraulically connected.

Capture Zone

Under non-pumping conditions, the overburden is generally dry throughout the year, except in the vicinity of the extraction wells. Under pumping conditions, the overburden is dewatered because the saturated thickness of the overburden is low and the pumps are set below the

bedrock surface. Pumping the northern extraction system removes groundwater from storage and lowers the groundwater surface into the upper bedrock until a significant recharge event occurs.

The configuration of the potentiometric surface in the overburden aquifer and upper bedrock aquifer are shown on Figures 3-6 and 3-7, respectively, for November 10, 2001. As shown by both figures, pumping the extraction wells caused groundwater flow generally in a southeast direction, with radial flow toward individual pumping wells, as indicated by closed contours around those wells. Similar to the previous monthly groundwater contours, a cone of depression exists in the vicinity of RW-4 extending to MW-40B. The core of the contaminant plume is located between RW-4 and RW-8, so pumping of the northern extraction system intercepts downgradient migration. Extraction well MW-35B is located in the former source area and pumping of this well is intended to reduce the PCE mass of the plume. Again, similar to previous months, groundwater flow is generally from Meddybemps Lake to the extraction system. The Dennys River may also contribute some recharge to RW-9, RW-10, RW-11, MW-39B and MW-40B, that are located in the southern half of the northern extraction system.

Groundwater velocities have been estimated based on a tracer test using potassium bromide (KBr^-) as the tracer (Appendix D). A slug of potassium bromide at a concentration of 110 mg/L was added in equal volumes (3.65 liters) to upgradient wells IW-1B to IW-4B. Monitoring indicated the Br- peak occurred in approximately 3 days at downgradient extraction wells RW-2, RW-3, RW-4, RW-8, RW-9 and laterally to monitoring well MW-29B2. The bromide peak occurred 1 or 2 days later at IN-1B1, MW-39B, RW-10, and RW-11, probably due to low transmissivity and/or greater travel distances. The bromide peak was not discernable at IN-1B2, IN-2B2, MW-34B1, MW-34B2, and MW-35B2 due to the presence of permanganate in these wells. The distance between the IW wells and the RW wells where the Br- peak occurred at 3 days ranged from 55 feet (between IW-4 and RW-2) to 110 feet (between IW-2 and RW-4). Therefore, the velocity of a conservative tracer ranges from 18 to 36 feet/day while extracting 8 gpm and adding 8 gpm upgradient. Under these conditions the hydraulic gradient normal to equipotentials was approximately 0.082 (7 feet/85 feet).

Because the travel velocity is proportional to the hydraulic gradient, it is possible to calculate the travel velocity under different hydraulic gradients. While the extraction system was operating, on June 22, 2001, the hydraulic gradient was approximately 0.04; therefore velocity ranged from

9 to 18 feet/day. Under non-pumping conditions, the hydraulic gradient was about 0.026; therefore, the groundwater velocity ranged from 5.7 to 11.4 feet/day. These velocities represent movement of a conservative tracer probably through transmissive fractures across the PCE residual source area.

The capture zone associated with the line of northern plume extraction wells along the west side of the Dennys River is delineated from the Meddybemps Lake (north) to MW-4 (south). The extent of the capture zone indicates the extraction system is cutting off the northern plume west of the Dennys River.

PCE Concentrations Prior to Phase I Oxidation

Groundwater sampling was conducted in the Spring of 2000 to establish baseline conditions prior to the addition of the selected oxidizer, sodium permanganate. Selected monitoring wells and recovery wells were sampled and analyzed for VOCs. A discussion of the baseline results for monitoring and extraction wells in the surficial and bedrock aquifers in the northern plume follows.

Surficial Aquifer

Figure 3-8 shows the estimated extent of PCE concentrations during April/May/June 2000 in the overburden aquifer prior to the first addition of sodium permanganate. The extent is somewhat smaller than the plume extent delineated in June 1999. This smaller extent is attributed to the fact that much of the overburden unit was unsaturated during the April/May/June 2000 sampling event. During April/May/June 2000, the highest PCE concentration in the surficial aquifer was detected in monitoring well MW-3S (3000 µg/L). The highest detected PCE concentration during the previous sampling event (June 1999) was 98 µg/L at MW-3S. PCE was also detected in MW-23S (at 130 µg/L) during the baseline sampling. Other VOCs detected during June 1999 were also detected during the April/May/June 2000 sampling. The other VOCs present in the overburden plume included cis-1,2-dichloroethene (cis-1,2-DCE), trichloroethene (TCE), methylene chloride, and acetone. However, these other VOCs were present at less than 2 µg/L. Overall, VOCs presence in the overburden portion of the northern plume prior to Phase I was limited.

The increased VOC concentrations in MW-3S were attributed to contaminated bedrock groundwater recharging the overburden when the water table rises in response to precipitation events (TtNUS, 2000d). The migration of elevated PCE groundwater was probably caused by operation of the NTCRA system.

At the time of groundwater sampling, several overburden wells (MW-42S, MW-43S, MW-44S, MW-45S, and MW-46S) had not been installed limiting the delineation of PCE in the southwestern portion of the northern plume. In addition, the following recovery wells, screened across the overburden and bedrock had not been installed: RW-8, RW-9, RW-10, and RW-11.

Bedrock Aquifer

Figure 3-9 shows the estimated lateral extent of PCE concentrations in the upper bedrock during April/May/June 2000. The highest detected PCE concentration in the northern plume bedrock aquifer during April/May/June 2000 was 12,000 µg/L at MW-3B, which is screened in the shallow bedrock. Historically, PCE concentrations in MW-3B have been as high as 3,700 µg/L. Monitoring wells MW-34B1 and MW-35B1, which are screened in the shallow fractured bedrock, were sampled a few months earlier in January-February 2000 and contained elevated VOC concentrations (up to 7,200 µg/L).

The most highly contaminated portion of the bedrock plume is centered in the area represented approximately by MW-3B, MW-34B1/B2, MW-35B1/B2, MW-36B1/B2 and RW-3. PCE has been virtually undetected in the upgradient portion of the northern plume, represented by MW-28B and MW-29B. At the time of sampling, several bedrock wells (MW-41B, MW-42B, and MW-43B) had not been installed limiting the delineation of PCE in the southwestern portion of the northern plume. In addition, the following recovery wells, screened across the overburden and bedrock had not been installed: RW-8, RW-9, RW-10, and RW-11

PCE has also been detected extending as far south as MW-4 (1 µg/L). In the nested well pair RW-7B1 and RW-7B2, PCE has been detected since June 1999. PCE concentrations detected in RW-7B1 and RW-7B2 during June 2000 were 17 µg/L and 240 µg/L, respectively. Review of the compiled data indicates that PCE concentrations are slowly increasing in this portion of the bedrock aquifer, especially in the lower bedrock interval. These results suggest that PCE (and

other VOCs such as TCE) may be migrating away from the source area in the deep bedrock fractures, albeit at a gradual rate.

The VOCs vertical extent is based on the supplemental bedrock investigation coupled with the more current groundwater analytical data for the northern plume. The vertical extent of VOCs contamination in the northern plume was estimated to extend to at least 220 feet below ground surface based on PCE detected at monitoring wells screened in the deep bedrock unit (MW-34B2, MW-35B2, MW-39B2, MW-40B2, and RW-7B2). These wells were constructed as nested wells or contained packers to isolate the shallow and deep bedrock fractures from each other; migration of PCE from the shallow the bedrock fractures into the deeper bedrock fractures within each well is thereby minimized or eliminated. The repeated rounds of purging and sampling have not resulted in a decrease of PCE concentrations in the deep wells. Therefore, it is reasonable to conclude that PCE in the deep bedrock portions of these boreholes migrated from the shallow bedrock into the deeper bedrock via interconnected fractures.

Monitoring wells MW-39B and MW-40B were installed to depths of 220 feet bgs in order to assess VOCs presence in the deep bedrock. By installing MW-39B and MW-40B away from the most contaminated portion of the VOC plume, the potential for mobilizing VOCs from the upper bedrock into the deeper portions of the formation was minimized. The June 2000 NTCRA sampling data indicate that PCE was detected in MW-39B1 (upper bedrock) and MW-39B2 (lower bedrock) at 300 and 260 µg/L, respectively.

The distribution of PCE in the northern plume indicates that residual VOCs remain in the shallow bedrock aquifer in the area approximated by MW-3B, MW-20B, MW-34B, and MW-35B. The PCE concentrations in these wells varied between January 2000 and June 2000, which could be attributed to movement of the northern plume under the influence of pumping of the northern NTCRA extraction system.

The VOCs could be present as non-aqueous phase liquid (NAPL) in the bedrock fractures or are adsorbed into the bedrock matrix, and are continuing sources of groundwater contamination.

While variations in PCE concentrations occur over time in response to the amount of precipitation infiltration, overall the shallow bedrock appears to be more highly contaminated by VOCs in the core of the plume. In the downgradient portion of the plume, southwest of the core area, VOCs contamination appears to be present at lower concentrations, but situated deeper in bedrock.

NTCRA Extraction Wells

The NTCRA extraction wells were selected for evaluation of baseline VOC and metals concentrations because data was available at these wells both before and after the Phase I and II in-situ oxidation applications, and because samples collected from these wells represent a larger volume of the aquifer relative to individual monitoring wells that are not pumped.

Table 3-2 summarizes the pre-Phase I treatability study VOC and metals concentrations from the NTCRA extraction wells (RW-2, RW-3, RW-4). PCE and TCE exceeded EPA's Maximum Contaminant Levels (MCLs) and Maine's Exposure Guidelines (MEGs). PCE concentrations were higher than TCE: PCE concentrations were as high as approximately 3000 ug/L (RW-2, -3, -4), while maximum TCE concentrations reached approximately 120 ug/L (RW-3). Of the TAL metals, manganese and thallium exceeded drinking water standards. Manganese concentrations exceeded the 200 ug/L MEG at RW-3 and RW-4 (278 ug/L to 1530 ug/L). Thallium concentrations exceeded both the MCL (2 ug/L) and the MEG (0.4 ug/L) at concentrations of 8.4 to 12.4 ug/L (RW-2, -3 and –4).

3.3.2 Southern Plume Area

Surficial Aquifer - The sand and gravel fill and subaqueous sand and gravel units act as a limited surficial aquifer, with a saturated thickness ranging from 0 to 8 feet. The direction of bulk groundwater flow is to the southeast, toward the Dennys River discharge area. The horizontal hydraulic gradient ranges from approximately 0.01 to 0.02 across the southern plume to the Dennys River. The hydraulic conductivity ranges from 17 to 78 feet/day in coarse-grained glaciomarine sediments (Lyford and others, 1999).

Aquitard - The fine-grained facies of the Presumpscot Formation and glacial till units act as an aquitard due to their fine-grained and compact characteristics. The Presumpscot formation

continuously overlies the subaqueous sand unit, except in the area where contaminated soils north of Rt. 191 were excavated during the NTCRA. The glacial till underlies the subaqueous sand unit and is discontinuous. The hydraulic conductivity of the glacial till varies from 0.1 to 1.0 feet/day (Lyford and others, 1999).

Bedrock Aquifer – In bedrock, groundwater is transmitted through interconnected, open fractures. The upper few feet is highly fractured and interconnected. With increasing depth, the density of interconnected fractures decreases. The depth to groundwater ranges from 12 to 20 feet bgs in the southern portion of the Site. Based on data summarized by the USGS (Lyford and Others, 1998) and observations during drilling conducted by TtNUS, the short-term yield from bedrock wells varies from less than 0.1 to 25 gpm (MW-22B) in the southern plume area of the Site. The configuration of the potentiometric surface of the bedrock aquifer shows the general direction of groundwater flow is toward the southeast, toward the Dennys River. The transmissivity ranged from 0.09 ft^2/day to 130 ft^2/day in the fractured bedrock (Lyford and others, 1999). More detailed studies, using borehole flowmeters indicated the transmissivity of 95 percent of the individual water-bearing fracture and fracture zones showed less than 19.5 ft^2/day (Hansen and others, 1999).

Water-bearing fracture zones and fracture orientation data are from borehole geophysical logging performed by TtNUS's subcontractor, Northeast Geophysical Services, and unpublished geophysical logs of the USGS (Hansen B., written communication, January 1999). The orientation of water-bearing fractures (dip and dip direction) is summarized below:

- IS-1B – Most transmissive fractures were observed at 19 to 22 feet btoc, 29.5 feet btoc, and 90.5 feet btoc. The dip of fractures at 19-22 feet could not be measured. Five low-angle fractures at 29.5 feet btoc dip west-northwest. One moderate-angle fracture at 90.5 feet btoc dips northwest.

- IS-2B – Most transmissive fractures were observed at 29 to 32.5 feet btoc, where the dip could not be measured, and at 106 feet btoc, where two low-angle fractures dip northwest.

In addition, the USGS performed surface and borehole geophysical surveys (Hansen and others, 1999) in the vicinity of the southern plume area. USGS studies indicated most water-

yielding fractures dip to the south. In general, most of the low-angle water-yielding fractures dip west-northwest to south-southwest and most of the high-angle water-yielding fractures generally dip east-southeast or south.

Capture Zone

The configuration of the potentiometric surface in the overburden aquifer and upper bedrock aquifer are shown on Figures 3-6 and 3-7, respectively, for November 10, 2001. As shown by both figures, pumping the extraction wells caused groundwater flow generally in a southeast direction, with radial flow toward individual pumping wells, as indicated by closed contours around those wells. A cone of depression exists in the vicinity of RWS-3, -5 and –6. The core of the contaminant plume is located between RWS-3 and RWS-6.

The capture zone associated with the line of northern plume extraction wells along the west side of the Dennys River is delineated from the vicinity of MW-19S/B (south of the infiltration gallery) to south of RWS-1. The extent of the capture zone indicates the extraction system is cutting off the southern plume west of the Dennys River.

PCE Concentrations Before Phase I Oxidation

Sampling of selected monitoring wells and addition wells was performed by TtNUS during April-May 2000 to establish baseline VOC conditions in the southern plume prior to the start of the Phase I oxidation. The analytical data also provides information regarding Site conditions following the NTCRA soil removal actions that were completed during 1999.

In general, VOC concentrations in the southern plume are much lower than those in the northern plume. Historically, the overburden aquifer was more contaminated than the bedrock aquifer, and the most contaminated portion of the plume is situated in the vicinity of MW-8S.

Surficial Aquifer

Figure 3-8 shows the estimated extent of the southern plume in the surficial aquifer during April/May/June 2000. The highest PCE concentration detected in April/May/June 2000 was in MW-8S (350 µg/L). In June 1999, PCE was higher (570 µg/L) at MW-8S.

Bedrock Aquifer

Figure 3-9 shows the extent of PCE in bedrock in April/May/June 2000. The highest detected PCE concentrations during June 1999 were at MW-8B1 (52 ug/L) and MW-8B2 (200 µg/L).

NTCRA Extraction Wells

Table 3-3 summarizes pre-Phase I VOC and metals concentrations from the NTCRA extraction wells (RWS-1, RWS-3, RWS-5, RWS-6, and RWS-7). Of the VOCs detected, only PCE exceeded the MCL (5 ug/L) and the MEG (3 ug/L). PCE concentrations ranged from 6 to 460 ug/L (RWS-5). Of the TAL metals detected, only lead exceeded drinking water standards. Lead ranged from 13.2 to 23.1 ug/L in three samples collected from RWS-5 and only one of these samples exceeded the MCL (15 ug/L). Manganese concentrations ranged from 31 to 95 ug/L in three samples collected from RWS-5. Samples for metals analysis were not collected from the remaining extraction wells.

4.0 IN-SITU CHEMICAL OXIDATION TREATABILITY STUDY RESULTS

Results of the in-situ chemical oxidation treatability study performed at the Site to evaluate the effectiveness of sodium permanganate as an oxidant to decrease VOC concentrations (primarily PCE) are presented in this section for the northern and southern plumes.

4.1 Northern Plume

In-situ oxidation treatability tests were conducted in two phases to evaluate the effectiveness of two separate sodium permanganate delivery methods. The results of the Phase I and II pilot tests for the northern plume are presented below.

4.1.1 Phase I-Initial Sodium Permanganate Addition (July 2000)

The Phase I treatability study was initiated in July 2000 with the addition of 2 gallons of 20 percent sodium permanganate solution into each of four northern plume bedrock wells (MW-34B1, MW-35B1, IN-1B, and IN-2B) located in the core of the plume. Because of the proximity of the Dennys River to the permanganate addition wells, only an estimated three times the stoichiometric quantity of permanganate was added, instead of the more typical 10 times stoichiometric ratio.

EPA requested recirculation of unspent permanganate during the Phase I study. Unspent permanganate mixed with groundwater extracted from the southern plume was collected in a 20,000 gallon frac tank. The extracted groundwater was tested and estimated to contain 30 mg/L of permanganate. This water was transferred to upgradient wells in the northern and southern plumes. Recirculation allowed the use of unexpended permanganate to destroy more PCE and enhanced flushing of the contaminant plumes. The recirculation of the extracted permanganate solution continued through the end of August 2000, when permanganate was no longer visible in the southern extraction wells.

4.1.2 PCE Concentrations After Phase I- Initial Permanganate Addition (September 2000)

Sampling of selected monitoring wells and addition wells was performed by TtNUS in September 2000 to evaluate the effectiveness of the initial Phase I permanganate addition into

the core of the northern plume. The September 2000 groundwater analytical data is summarized on Table 4-1. Figures depicting the extent of PCE were not prepared due to the limited number of wells sampled.

Comparison of PCE concentrations in common wells sampled in April/May/June 2000 (before the initial Phase I addition) and in September 2000 (the first sampling event after the Phase I addition) indicated the following:

Overburden Aquifer

Due to dry conditions, only one overburden well (MW-23S) was sampled during both sampling events. PCE concentrations increased from 130 to 380 ug/L (MW-23S) after the Phase I permanganate addition. The increase in PCE may have been caused by one or more factors operating separately or together. These factors include recharge from precipitation, recharge from addition of permanganate, and operation of the extraction system which could cause a shift in the PCE plume and/or desorption of PCE from organic carbon or other aquifer materials as a result of the geochemical changes caused by the introduction of sodium permanganate.

Upper Bedrock Aquifer

The PCE concentration increased in six wells after the Phase I additions. The largest increase was measured in MW-20B (5 to 12,000 ug/L) and in an addition well MW-35B1 (460 to 16,000 ug/L), which is located less than 10 feet from MW-20B. Well MW-35B2 also showed an abrupt increase in PCE (710 to 14,000 ug/L). These abrupt increases in PCE concentrations resulted from the steeper concentration gradients, in the vicinity of a residual PCE source in the upper fractured bedrock, caused by the high concentrations of permanganate added in Phase I.

Other wells (MW-34B1, MW-36B1, and MW-36B2) also showed increases of PCE at concentrations within the range of variation measured prior to the Phase I addition.

PCE decreased from 12,000 to 13 ug/L in MW-3B. PCE also decreased slightly in MW-36B2, but the decrease was within the range of historical PCE concentrations.

Although permanganate had been added into four bedrock wells in the core of the plume, and monitoring of the groundwater field parameters and color indicated that the permanganate was being consumed (based on changes in color, conductivity, and redox potential), high levels of PCE were observed in some wells. The increased PCE concentrations in groundwater samples, was likely the result of the increased concentration gradient after permanganate was added to the aquifer.

4.1.3 Phase I-Second Permanganate Addition (September 2000)

After reviewing the September 2000 analytical results it was concluded that the initial dose of sodium permanganate was insufficient. The first dose may have been consumed by chemicals or ions (naturally occurring or synthetic) present in the northern plume, and an additional dose was needed to destroy the PCE remaining in these addition wells. In late September 2000, a second dose of 20 percent sodium permanganate was added into MW-20B (3 gallons), MW-34B1 (0.5 gallons), MW-35B (4 gallons), IN-1B (1 gallon) and IN-2B (0.5 gallons). In addition, because an elevated PCE concentration was detected in MW-3B (12,000 µg/L) in May 2000, a one-time dose of permanganate (2 gallons) was added to this well.

4.1.4 PCE Concentrations After Phase I – Second Permanganate Addition (December 2000)

Groundwater samples were collected from selected northern plume wells during November 2000 to evaluate the effectiveness in decreasing the aquifer PCE concentrations. In December 2000, a comprehensive round of groundwater sampling was conducted to assess the overall status of groundwater contamination at the Site following the preliminary permanganate doses. The November and December 2000 PCE groundwater analytical data is summarized on Table 4-1. PCE was measured in nine common bedrock wells in November and December 2000. The estimated extent of PCE for the December 2000 sampling event for the overburden and bedrock aquifers is shown on Figures 4-1 and 4-2, respectively. Comparison of PCE concentrations in common wells sampled in September 2000, and November/December 2000 sampling events indicated the following changes:

Overburden Aquifer

Due to dry conditions, only one overburden well (MW-23S) was sampled during both sampling events. PCE concentrations decreased from 380 to 16 ug/L (MW-23S) after the Phase I permanganate addition.

Comparison of the extent of PCE in the overburden aquifer at the Site in April/May/June 2000 (Figure 3-8) to that in December 2000 (Figure 4-1) suggested the PCE plume was less extensive in December 2000. However, only two wells were sampled in December 2000 because groundwater levels had declined.

Bedrock Aquifer

PCE increased from 1500 to 22,000 ug/L at MW-34B1 between September and November 2000, then decreased from 22,000 to 2900 ug/L one month later. Similar trends were measured at MW-20B and MW-35B1 over the same time period. In contrast, PCE concentrations at IN-1B and IN-2B were similar during September and November 2000, then increased one month later at IN-1B (1800 to 5400 ug/L) and at IN-2B (2100 to 3100 ug/L).

PCE decreased from 13 to 7 ug/L in MW-3B between September and December 2000. Other wells (MW3B, MW-35B2, and MW-36B2) showed decreases between September and December 2000. PCE also decreased slightly in MW-35B2 and MW-36B2, but the decreases were within the range of historical PCE concentrations of each well.

Comparison of the extent of PCE in the bedrock aquifer at the Site in April/May/June 2000 (Figure 3-9) to that in December 2000 (Figure 4-2) indicated PCE concentrations in the core of the plume increased, as noted above, in both the shallow and deeper bedrock intervals sampled.

4.1.5 Phase I - Third Permanganate Addition (January 2001)

Based on the December 2000 analytical results, EPA and TtNUS concluded that additional permanganate was needed to destroy the remaining PCE in the core of the northern plume. A third dose was applied to destroy the remaining PCE. Because of the cold weather conditions and concern for low reaction rates, a 40 percent solution of permanganate was first added into

the five wells, followed by warm water (about 100 degrees F) added to the top of the well column. Because the sodium permanganate is denser than water, it has the tendency to sink into the bottom of the water column. By filling the water columns with the warm water, it was thought that this could aid in pushing the permanganate into the bedrock fractures. The warm water could also potentially increase the oxidation rate in the water column. In January 2001, 40 percent permanganate solution was added to MW-20B (4 gallons), MW-34B1 (6 gallons), MW-35B1 (8.5 gallons), MW-35B2 (8.5 gallons), IN-1B (4 gallon) and IN-2B (4 gallons).

4.1.6 PCE Concentrations After Phase I - Third Addition (March-April 2001)

Groundwater samples were collected from a limited number of bedrock wells in March-April 2001 to evaluate the effect of the Phase I permanganate additions. The March-April 2001 groundwater analytical data is summarized on Table 4-1.

Comparison of PCE concentrations in common wells sampled in December 2000 and March/April 2001 indicated the following changes:

The largest increase in PCE over this time period was measured at MW-34B1, which increased from 2900 to 7400 ug/L. Similar trends were measured at MW-20B (5100 to 8000 ug/L) and at MW-35B1 (6800 to 9700 ug/L). PCE also increased slightly at MW-4B, from "not detected" (<1 ug/L) to 13 ug/L.

PCE decreased in the remaining bedrock wells sampled, as follows: MW-34B2 (5 to < 1 ug/L), MW-35B2 (6300 to 360 ug/L), MW-36B1 (1700 to 810 ug/L), MW-36B2 (360 to 15 ug/L), MW-39B1 (2000 to 500 ug/L), IN-1B (5400 to 22 ug/L), and at IN-2B (3100 to 2 ug/L).

The abrupt increases in PCE concentrations since the start of the Phase I treatability study in July 2000 are likely affected by the increased concentration gradient between the permanganate and residual PCE in the upper fractured bedrock aquifer.

4.1.7 Phase II Sodium Permanganate Addition (May 2001)

The Phase II treatability study was performed from April 30, 2001 through May 27, 2001. In Phase II, permanganate was added under pressure (20-30 psi) to selected small-diameter

(0.75-inch ID) direct push wells over a 3-week period (April 30 – May 20, 2001). During the fourth week (May 21-27, 2001), water was added to the small-diameter (SD) wells. Throughout this four-week period, field parameters were monitored in selected wells.

Permanganate additions started at the northern most row on May 1, 2001 and progressed to downgradient rows through May 13, 2001. On May 9th, permanganate was observed in the discharge from the recovery wells and RW-2 was observed to contain permanganate. No other significant changes were noted in the field parameters in bedrock wells. Additional direct push wells were installed at the midpoints between each of the rows. On May 16th, pink permanganate was observed in RW-11. On May 17th, permanganate was added to the SD wells located between rows 3 and 4. Throughout the fourth week, recovery wells were monitored for color and no permanganate was observed. On May 23-24th, all direct push wells in rows N1 through N4 were flushed with water.

4.1.8 PCE Concentrations After Phase II Addition (June 2001)

Groundwater sampling was performed in June 2001 to assess the effect of the Phase II permanganate addition. The June 2001 groundwater analytical data is summarized on Table 4-1. The estimated extent of PCE for the June 2001 sampling event for the overburden and bedrock aquifers is depicted in Figures 4-3 and 4-4, respectively. A comparison of the March/April 2001 sampling event to the June 2001 event follows.

Only one overburden well (MW-42S) was sampled in both March/April 2001 and in June 2001. PCE concentrations decreased in MW-42S from 300 to 100 ug/L. Other overburden wells were dry during one or both sampling events, or were not sampled.

Most wells completed in the bedrock showed decreases in PCE concentrations as follows: MW-35B1 (from 9700 to 2100 ug/L), MW-20B (from 8000 to 2500 ug/L), MW-34B1 (from 7400 to 1300 ug/L), MW-39B1 (from 500 to 160 ug/L), and RW7B1 (from 500 to 220 ug/L).

Extraction wells completed in both the overburden and bedrock showed decreases in PCE concentrations: RW-3 (2400 to 1600 ug/L), RW-9 (from 690 to 230 ug/L), RW-10 (from 610 to 25 ug/L), RW-8 (from 270 to 83 ug/L), RW-9 (from 690 to 230 ug/L), RW-10 (from 610 to 250

ug/L), and RW-11 (from 150 to 24 ug/L). Only one recovery well did not show a significant change in PCE concentrations: RW-4 (from 1900 to 1700 ug/L).

As indicated above, the highest PCE concentrations occurred at MW-20B, MW-34B1, and MW-35B1, which were completed in the upper 50 feet of bedrock. Low PCE concentrations were measured in deeper bedrock intervals (MW-34B2, IN1-B2, and IN2-B2). While PCE concentrations increased significantly in IN-1B (from 22 to 3900 ug/L) and IN-2B (from 2 to 1300 ug/L), located immediately downgradient of the residual source, these wells transmit low amounts of water and appear to respond to changes in PCE at the source more slowly than other wells downgradient of MW-34B and MW-35B.

4.1.9 PCE Concentrations After Phase II Addition (November 2001)

Groundwater sampling was performed in November 2001 to assess the effect of the Phase II permanganate addition. The November 2001 groundwater analytical data is summarized on Table 4-1. The estimated extent of PCE for the November 2001 sampling event for the overburden and bedrock aquifers is estimated on Figures 4-5 and 4-6, respectively. A comparison of the November 2001 sampling event to the previous event in June 2001 at common wells follows.

Overburden wells were dry in November 2001 and not sampled.

Several bedrock wells showed significant increases in PCE concentrations: MW-34B1 (1300 to 6600 ug/L), IN-1B2 (25 to 300 ug/L), IN-2B2 (7 to 100 ug/L), MW-35B (extraction well) (2100 to 9100 ug/L), RW-4 (extraction well) (1700 to 2700 ug/L), and RW-11 (extraction well) (24 to 140 ug/L).

PCE decreased in some bedrock wells: MW-3B (1600 to 23 ug/L), MW-20B (2500 to 270 ug/L), MW-36B1 (840 to 230 ug/L), MW-36B2 (46 to 12 ug/L), IN-1B (3900 to 1400 ug/L), IN-2B (1300 to 140 ug/L), and RW-7B1 (220 to 90 ug/L). PCE concentrations in other wells remained about the same.

These results suggest there was a lag in the time required for permanganate to migrate from the direct push wells to bedrock fractures that contained residual. Groundwater levels have

continued to decline at the Site in response to a lack of significant recharge events and pumping groundwater from the extraction system. The lag is expected to be caused by slow migration rate of permanganate through unsaturated overburden and upper bedrock fractures. The distribution of elevated PCE in the overburden and upper bedrock suggest a residual source of PCE at less than 50 feet (below the top of bedrock), primarily in the vicinity of MW-35B and to a lesser extent near MW-34B.

4.1.10 PCE Changes Caused by Phase I and II Oxidations

This section summarizes changes in PCE concentrations before, during and after the Phase I and II sodium permanganate additions in the northern plume. PCE concentration versus time graphs for June 1999 through November 2001 are presented on Figures 4-7, 4-8, and 4-9 for the overburden, bedrock, and extraction wells, respectively. The PCE data for the graphs is from Table 4-1. Groundwater level trends at selected wells in the northern plume are depicted on Figure 4-10. An interpretation of the PCE vs. time graphs for the northern plume in the upper and deeper bedrock follows.

Bedrock

Bedrock wells showed decreases in PCE concentrations: MW-3B (12,000 to 23 ug/L), MW-23B (from 790 to 240 ug/L), MW-34B2 (from 78 to 24 ug/L), MW-36B2 (from 620 to 12 ug/L), and MW-39B1 (from 300 ug/L to 180 ug/L). Bedrock monitoring well RW-7B1 showed an increase in PCE from 27 to 90 ug/L.

Extraction Wells

Between April/May 2000 (before the initial permanganate addition) and November 2001 (post-Phase II addition), two extraction wells showed decreases in PCE concentrations: RW-2 (43 to 4 ug/L), and RW-3 (3200 to 110 ug/L). One extraction well showed increased PCE: RW-4 (from 490 to 2700 ug/L).

The persistence of PCE in the northern plume indicates the presence of PCE residuals. Because of the uncertainty in the distribution of residual PCE it is likely that multiple dead-end fractures exist that were not accessed by the oxidizer. It is hypothesized that dead-end

fractures contain residual PCE that gradually partition to the primary fractures and result in elevated PCE concentrations. Also, seasonal fluctuations in the groundwater elevations and groundwater extraction may alter groundwater flow and transport of the oxidizer.

4.1.11 Changes In Groundwater Metals Concentrations After Phase I and II Oxidations

Comparison of pre-Phase I and II results (Table 3-2) and post-Phase I and II results (Table 4-2) indicated metals increased. Aluminum, antimony, arsenic, lead, manganese, selenium, and thallium exceeded the MCLs and/or MEGs in unfiltered samples collected in November 2001. Because no samples for metals analysis were filtered it is unknown whether or not elevated concentrations are related to elevated turbidty.

4.2 Southern Plume

The in-situ oxidation using sodium permanganate was performed as one phase in the southern plume. The results of the Phase I treatability study are presented below.

4.2.1 Phase I Sodium Permanganate Addition

The Phase I treatability study was initiated in July 2000 with the addition of 14 gallons of 20 percent permanganate distributed into three overburden wells (MW-8S, MW-33S, IS-2S) and 11 gallons distributed into two bedrock wells (MW-8B, IS-2B) and one recovery well (RWS-6). The addition was done through direct pour. Because of the proximity of the Dennys River to the permanganate addition wells, only an estimated three times the stoichiometric quantity of permanganate was added, instead of the more typical ten times ratio.

Subsequently, field parameters were measured daily to monitor the effects of the additions and to monitor anticipated startup of both the northern and southern extraction wells to prevent migration to the Dennys River. The permanganate addition was performed with the groundwater extraction system inactive to provide the maximum reagent contact time in the formation. After the initial addition, permanganate was detected in the one of the southern extraction wells (RWS-5), and the extraction system was activated to prevent potential permanganate discharge into the Dennys River.

During the treatability study, the southern extraction wells were operated to prevent discharge of permanganate into the Dennys River. Recirculation allowed the use of unexpended permanganate to destroy more PCE, and constituted enhanced flushing of the contaminant plumes. The extracted groundwater, containing approximately 30 mg/L of permanganate, was recirculated into monitoring wells situated in the upgradient portions of the southern plume (MW-18S, MW-25S, MW-9S, MW-22B). The recirculation of the extracted permanganate solution continued through the end of August 2000, when permanganate was no longer observed in the southern extraction wells.

4.2.2 PCE Concentrations After Phase I Addition (September 2000)

Sampling of selected monitoring wells and addition wells was performed by TtNUS in September 2000 to evaluate the effectiveness of the initial Phase I permanganate addition into the core of the southern plume. PCE concentration contours in the overburden and upper bedrock aquifers, based on data from sampling events in December 2000, June 2001, and November 2001, are shown on Figures 4-1 through 4-6.

A comparison of results from the April/May 2000 sampling event (conducted prior to the initial Phase I permanganate addition) to the November 2001 sampling event follows:

Overburden Aquifer

Between April-May 2000 and June 2001, PCE concentrations at overburden wells decreased. Groundwater collected from well MW-8S decreased from 350 to 34 ug/L; MW-18S decreased from 42 to 24 ug/L; MW-25S decreased from 9 to 2 ug/L; MW-30S decreased from 93 to 17 ug/L; and MW-31S decreased from 170 to 43 ug/L. From June 2001 to November 2001, there were continued decreases in PCE at common overburden wells.

Bedrock Aquifer

Between April/May 2000 and June 2001, PCE concentrations decreased at several bedrock wells. Well MW-8B decreased from 150 to 4 ug/L; MW-22B decreased from 6 to less than 1 ug/L; MW-19B decreased from 3 to less than 1 ug/L; MW-11B decreased from 2 to less than 1

ug/L; and MW-25B decreased from 2 to less than 1 ug/L. Between June 2001 and November 2001, PCE concentrations increased slightly at MW-8B, MW-10B, MW-11B, and MW-22B.

Extraction Wells

Between April/May 2000 and June 2001, PCE concentrations decreased at several southern plume extraction wells (screened across the overburden and bedrock): RWS-5 (180 to 26 ug/L), RWS-6 (from 120 to 6 ug/L), RWS-7 (from 24 to 6 ug/L), and RWS-1 (from 6 to less than 1 ug/L). Between June 2001 and November 2001, PCE concentrations decreased slightly at RWS-3 and increased slightly at RWS-5, -6 and –7.

PCE concentration versus time graphs for June 1999 through November 2001 are presented on Figures 4-11, 4-12, and 4-13 for the overburden, bedrock, and extraction wells, respectively, in the southern plume. Groundwater level trends at selected southern plume wells are depicted on Figure 4-14.

The PCE vs. time graphs for both overburden and bedrock wells in the southern plume show declining PCE trends. Prior to the Phase I oxidation, PCE ranged from 6 to 350 ug/L in the overburden and from 2 to 150 ug/L in the upper bedrock. After the Phase I oxidation in September 2000, PCE ranged from 22 to 160 ug/L in the overburden and from 1 to 3 ug/L in the bedrock. Since September 2000, PCE concentrations decreased, ranging from less than 1ug/L to 11 ug/L in the overburden and less than 1 ug/L to 19 ug/L) in the fractured bedrock.

4.2.3 Changes in Concentrations of Metals in Groundwater After Phase I Oxidation

Analytical results of groundwater samples collected from extractions wells prior to the treatability study (Table 3-3) were compared to groundwater data collected after the Phase I and II oxidant applications (Table 4-3). The historical results (Table 3-3) indicated lead exceeded both the MCL and MEG in one sample collected from RWS-5. A total of three samples were collected for metals analyses and all were collected from RWS-5. The November 2001 results (Table 4-2) indicated unfiltered samples contained aluminum, arsenic, cadmium, lead, manganese, selenium, and thallium that exceeded EPA MCLs and/or Maine MEGs. Because no samples for metal analysis were filtered it is unknown whether or not elevated concentrations are related to elevated turbidity.

5.0 SUMMARY AND CONCLUSIONS

This section presents summary and conclusions regarding the evaluation of the effectiveness of in-situ sodium permanganate oxidant added to the northern and southern plumes of the Eastern Surplus Company Site. The effectiveness of this oxidant was based on an evaluation of groundwater quality data collected before and after the permanganate additions.

5.1 Northern Plume

Under non-pumping conditions, the northern VOC plume occurs in the overburden and bedrock aquifers and discharges into the Dennys River. The overburden aquifer is generally dry except in the southern portion where the saturated thickness in fine-grained materials increases to several feet. While the northern extraction system is operating, pumping causes dewatering of the overburden and depression of the groundwater surface in the fractured bedrock, and effects capture of the northern plume. The overburden is generally thin and mostly unsaturated while the extraction system is pumping. During injection-extraction operations, the extent of saturation in the overburden increases primarily in the southern portion of the plume where the bedrock surface slopes more steeply toward the Dennys River.

The results of borehole geophysics provided information about rock lithology, and the depth, orientation and yield of bedrock fractures. This information coupled with the results of drawdown testing and tracer testing confirmed that water-bearing fractures are interconnected. This information was important to confirm that wells selected for permanganate addition are connected to fractures that are in turn connected to the northern VOC plume. Groundwater sampling results in the northern plume indicated that VOCs (primarily PCE) are higher in the upper bedrock aquifer than the deeper bedrock aquifer.

Prior to the Phase I treatability study, the highest detected PCE concentration in this plume was 12,000 µg/L in MW-3B. The most contaminated portion of the northern plume occurs in the vicinity of MW-35B and to a lesser extent MW-34B. These elevated concentrations of PCE in groundwater are in an area that formerly contained highly contaminated soils and leaking containers of paints and solvents that were present prior to the NTCRA. Because the NTCRA removed contaminated soils and the containers, residual sources of PCE most likely occur in the upper fractured bedrock.

The persistence of PCE in the northern plume indicates the presence of PCE residuals and/or inadequate contact between the oxidizer and the VOC. It is likely that multiple dead-end fractures exist that were not accessed by the oxidizer. It is hypothesized that dead-end fractures contain residual PCE that gradually partition to the primary fractures and result in elevated PCE concentrations. Also, seasonal fluctuations in the groundwater elevations and groundwater extraction may alter groundwater flow and transport of the oxidizer.

Key factors for the rate of PCE oxidation using permanganate include: initial dose concentration, temperature, oxidizable matter present, contact time, and pH. The pH is the least likely influence because the pH in the aquifer is not expected to vary significantly.

Based on Site conditions, the rate of reaction in the bedrock aquifer is expected to be relatively slow because of:

- low temperatures in the aquifer (less than 50 degrees F or 10 degrees C measured in a variety of wells),

- low contact time because the permanganate may not have been adequately distributed into the fractured bedrock, and

- low permanganate concentration, if the permanganate had been depleted to satisfy the aquifer's oxidant demand (other oxidizable organic chemicals or metal ions).

Permanganate applications during Phase I resulted in increased PCE concentrations. The increase in the concentration gradient between the permanganate and residual PCE, likely increased the PCE concentration dissolved in groundwater.

Other oxidizable matter (naturally occurring organic matter, reduced metal) is likely present in the northern plume that exerts a "natural oxidation demand" (NOD). Sufficient quantities of oxidizers need to be applied that adequately address both the NOD and the demand of PCE.

The upper fractured bedrock probably contains PCE residuals that will act as continuing sources of groundwater contamination during precipitation and infiltration events.

The rate of PCE oxidation by sodium permanganate is typically controlled by the quantity (concentration) of permanganate applied, concentration of contaminants present, presence of other oxidizable matter, temperature, and how well the PCE and permanganate are mixed. Because of the low transmissivity of some of the fractures, the permanganate may not have been adequately distributed into the bedrock fractures to allow intimate mixing with PCE. Due to these factors, residual PCE remains unoxidized in the bedrock unit, despite the multiple applications of chemical oxidizer.

To address the remaining PCE in the bedrock aquifer, permanganate will need to be distributed *into the top of rock, into the fractures, and into the bedrock matrix to mix intimately with the PCE* to ensure complete oxidation.

In conclusion, PCE, as dissolved phase and as residual quantities of NAPL, is likely present in the upper bedrock (top of rock, closed-end fractures, and the bedrock matrix) and is a continuing source of groundwater contamination that needs to be addressed. In-situ oxidation with sodium permanganate is effective in destroying dissolved PCE in the bedrock aquifer, and increasing the concentration gradient, thereby increasing the dissolution of PCE from the PCE NAPL. In addition, the oxidant needs to be effectively delivered into the bedrock fractures to ensure adequate contact (i.e., residence time, oxidant concentration) with the PCE .

5.2 Southern Plume

In the southern portion of the Site, groundwater occurs in both the overburden and bedrock units and discharges into the Dennys River under non-pumping conditions. While the southern extraction system is operating, pumping causes depression of the groundwater surface which results in capture of the southern plume. Groundwater sampling results in the southern plume indicated that VOCs (primarily PCE) are higher in the surficial aquifer than the upper bedrock aquifer.

The results of borehole geophysics provided information about rock lithology, and the depth, orientation and yield of bedrock fractures. This information coupled with the results of drawdown testing confirmed that the surficial aquifer is connected with water-bearing fractures in the bedrock aquifer, and both aquifers are influenced by pumping the extraction wells.

Based on the results of the Phase I permanganate addition, PCE concentrations in the southern plume appeared to have declined considerably since the chemical oxidation treatability study was conducted. This is based on a review of groundwater analytical data from sampling events conducted prior to the Phase I addition (June 1999, April/May/June 2000), and subsequent events (September 2000, December 2000, March/April 2001, June 2001, November 2001) at common wells.

In conclusion, PCE concentrations have continued to decrease in both the overburden and bedrock of the southern plume as a result of removal of the contaminant source and addition of sodium permanganate. Unlike the northern plume, a residual source of PCE does not exist in the southern plume, as evidenced by the lack of elevated PCE approaching 10,000 ug/L. Low PCE concentrations (less than 50 ug/L) remain primarily in the overburden aquifer over a large area. It is estimated that several years of pumping may be required for the aquifer to reach the 3 ug/L MEG, if permanganate is not added in the future to accelerate aquifer remediation.

6.0 RECOMMENDATIONS

Based on the results of the treatability study, a set of goals for full-scale treatment was developed:

- enhance delivery and distribution of permanganate in the northern and southern groundwater plume,
- increase the oxidant mass to be delivered to the plumes,
- increase the residence/contact time, and
- increase the rate of oxidation within the plumes.

For the northern plume, the recommended technical approach includes the following proposed items:

- install new bedrock wells in the core of the plume to enhance delivery of permanganate to the residual PCE,
- obtain bedrock samples to assess potential PCE presence in the bedrock matrix,
- perform additional borehole geophysics to identify water bearing fractures,
- use discrete zone samplers to identify bedrock zones with elevated VOCs,
- perform packer tests to determine oxidant injection pressures in injection wells,
- install a groundwater recirculation and oxidant metering system to maximize the distribution of permanganate at adequate doses into the bedrock unit, and
- enhance delivery of oxidant to the top of the bedrock surface through the use of the direct push application wells.

For the southern plume, the recommended technical approach includes the following proposed items:

- install a second groundwater recirculation and oxidant metering system to maximize the distribution of permanganate at adequate doses,
- use the existing array of direct push application wells to distribute permanganate throughout the overburden aquifer.

A full-scale in-situ treatment plan was developed and is included in Appendix E of this report. The plan was provided to EPA and MEDEP in June 2002. Full-scale treatment was initiated during August 2002.

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TABLES

TABLE 2-1
WELL CONSTRUCTION SUMMARY
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Well Identification	Surveyed Measuring Point	Elevation of Measuring Point (feet-NGVD)	Elevation of Ground Surface (feet-NGVD)	Depth to Top of Bedrock (feet-bgs)	Elevation of Bedrock (feet-NGVD)	Screened (s) or Open Hole (o) Interval (feet-bgs)	Elevation Bottom of Open Interval (ft-NGVD)
MW-1B	TS (4-in)	204.18	201.60	34.60	167.00	38 - 53 (s)	148.60
MW-3S	TPVC (2-in)	178.14	178.25	-	-	3.5 - 7.8 (s)	170.45
MW-3B	TPVC (2-in)	179.89	177.34	9.00	168.34	13.3 - 23.3 (s)	154.14
MW-4S	TPVC (2-in)	177.60	174.84	-	-	13 - 18 (s)	156.84
MW-4B	TPVC (2-in)	176.51	174.75	19.50	155.25	24.7 - 39.7 (s)	135.05
MW-5S	TPVC (2-in)	182.06	179.86	-	-	10 - 13 (s)	166.86
MW-6S	TPVC (2-in)	184.71	182.34	-	-	4.5 - 7 (s)	175.34
MW-7S	TPVC (2-in)	180.09	177.79	17.00	160.79	12 -17 (s)	160.79
MW-7B	TPVC (2-in)	178.75	177.81	18.00	159.81	21 - 117.8 (o)	60.01
MW-8S	TPVC (2-in)	169.14	167.30	16.50	150.80	14-16.5 (s)	150.80
MW-8B	TS (6-in)	169.35	169.04	20.50	148.54	25.7-124 (o)	45.04
MW-9S	TPVC (2-in)	175.52	174.03	16.50	157.53	14-16.5 (s)	157.53
MW-10S	TPVC (2-in)	176.13	174.42	22.00	152.42	18-23 (s)	151.42
MW-10B	TS (6-in)	175.64	174.24	20.00	154.24	26.4-120 (o)	54.24
MW-11S	TPVC (2-in)	170.70	169.34	26.00	143.34	21-26 (s)	143.34
MW-11B	TS (6-in)	170.63	169.69	29.00	140.69	34-132 (o)	37.69
MW-12S	TPVC (2-in)	200.21	199.11	22.00	177.11	19-21.5 (s)	177.61
MW-12B	TS (6-in)	201.34	200.13	22.50	177.63	27.7-138 (o)	62.13
MW-13S	TPVC (2-in)	174.14	171.36	14.00	157.36	11-13.5 (s)	157.86
MW-14B	TS (6-in)	187.33	185.70	3.50	182.20	9.4-120 (o)	65.70
MW-15S	TPVC (2-in)	179.32	178.46	36.00	142.46	26-36 (s)	142.46
MW-15B1	TPVC(1.25in)	180.03	178.97	39.00	139.97	70.5-80.5 (s)	98.47
MW-15B2	TPVC(1.25in)	180.02	178.97	39.00	139.97	89.5-99.5 (s)	79.47
MW-16S	TPVC (2-in)	183.48	182.88	36.00	146.88	28-38 (s)	144.88
MW-16B1	TPVC(1.25in)	183.89	182.18	38.00	144.18	60-75 (s)	107.18
MW-16B2	TPVC(1.25in)	183.88	182.18	38.00	144.18	105-120 (s)	62.18
MW-17S	TPVC (2-in)	174.34	172.83	18.00	154.83	15-17.5 (s)	155.33
MW-18S	TPVC (2-in)	174.82	172.81	18.00	154.81	16-18.5 (s)	154.31
MW-19S	TPVC (2-in)	178.46	177.02	11.80	165.22	9.3-11.8 (s)	165.22
MW-19B	TPVC (2-in)	178.17	176.46	18.50	157.96	20-35 (s)	141.46
MW-20S	TPVC (2-in)	180.26	178.56	6.00	172.56	3.5 - 6 (s)	172.56
MW-20B	TPVC (2-in)	180.66	178.63	5.50	173.13	11 - 21 (s)	157.63
MW-22B	TS (6-in)	174.23	172.35	18.00	154.35	25-49 (o)	123.35
MW-23S	TPVC (2-in)	177.96	175.95	8.00	167.95	3.5 - 7.5 (s)	168.45
MW-23M	TPVC (2-in)	177.94	176.19	7.50	168.69	7.5 - 14.5 (s)	161.69
MW-23B	TPVC (2-in)	177.32	175.68	8.00	167.68	16.5 - 32.25 (s)	143.43
MW-24B	TPVC (2-in)	181.11	179.06	8.60	170.46	14 - 24 (s)	155.06
MW-25S	TPVC (2-in)	177.32	175.74	-	-	7.5 - 17.5 (s)	158.24
MW-25B	TPVC (2-in)	177.49	175.57	18.50	157.07	20 - 35.5 (s)	140.07
MW-26B	TPVC (4-in)	172.81	172.72	12.00	160.72	45-190 (o)	-17.28
MW-27B	TPVC (6-in)	179.83	177.43	5.50	171.93	8 - 27 (o)	150.43
MW-28B1	TPVC (1.25-in)	182.35	184.57	5.00	179.57	23 - 43 (s)	141.57
MW28B2	TPVC (1.25-in)	182.42	184.57	5.00	179.57	63 - 78 (s)	106.57
MW-29B1	TPVC (1.25-in)	182.46	181.03	4.00	177.03	29 - 39 (s)	142.03
MW-29B2	TPVC (1.25-in)	182.46	181.03	4.00	177.03	57 - 77 (s)	104.03
MW-30S	TPVC (2-in)	170.94	168.88	20.50	148.38	8.5 - 20.5 (s)	148.38
MW-31S	TPVC (2-in)	168.15	166.05	15.50	150.55	7.0 - 15 (s)	151.05
MW-32S	TPVC (2-in)	171.11	169.00	-	-	11.5 - 17.5 (s)	151.50
MW-33S	TPVC (2-in)	171.66	169.51	-	-	11.5 - 17.5 (s)	152.01
MW-34B1	TPVC (1.25-in)	181.06	179.38	7.00	172.38	6 - 21 (s)	158.38
MW34B2	TPVC (1.25-in)	181.06	179.38	7.00	172.38	51 - 66 (s)	113.38
MW-35B	TMC	180.30	179.04	7.25	171.79	7 - 67 (s)	112.04
MW-36B1	TPVC (1.25-in)	169.99	167.78	7.60	160.18	28 - 43 (s)	124.78
MW36B2	TPVC (1.25-in)	170.07	167.78	7.60	160.18	128 - 143 (s)	24.78
MW-37B1	TPVC (1.25-in)	178.26	176.60	23.50	153.10	45 - 65 (s)	111.60
MW-37B2	TPVC (1.25-in)	178.26	176.60	23.50	153.10	74 - 92.2 (s)	84.40
MW-37SB	TPVC (2-in)	176.83	176.73	24.00	152.73	22-35.3 (s)	141.43
MW-38B	TS (6-in)	190.61	188.89	29.70	159.19	12 - 30 (o)	158.89
MW-39B	TMC	177.11	174.29	15.00	159.29	10 - 215 (s)	-40.71
MW-40B	TMC	177.18	175.78	21.30	154.48	14 - 219 (s)	-43.22
MW-41B1	TPVC (1.25-in)	176.63	176.25	9.00	167.25	100 - 115 (s)	61.25
MW-41B2	TPVC (1.25-in)	176.67	176.25	9.00	167.25	160 - 175 (s)	1.25
MW-42S	TPVC (2-in)	179.58	176.51	--	--	11 - 16 (s)	160.51
MW-42B1	TPVC (1.25-in)	178.13	176.63	24.50	152.13	20 - 35 (s)	141.63
MW-42B2	TPVC (1.25-in)	178.17	176.63	24.50	152.13	105 - 120 (s)	56.63
MW-42SB	TPVC (2-in)	179.27	177.06	--	--	4.0 - 7.5 (s)	169.56
MW-43S	TPVC (2-in)	180.26	177.21	--	--	12.5 - 17.5 (s)	159.71
MW-43B1	TPVC (1.25-in)	178.22	177.22	22.00	155.22	100 - 115 (s)	62.22
MW-43B2	TPVC (1.25-in)	178.26	177.22	22.00	155.22	150 - 165 (s)	12.22
MW-44S	TPVC (2-in)	177.63	175.68	--	--	9 - 14 (s)	161.68
MW-44SB	TPVC (2-in)	178.26	175.91	--	--	3.0 - 6.0 (s)	169.91

TABLE 2-1 (CONT'D)
WELL CONSTRUCTION SUMMARY
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Well Identification	Surveyed Measuring Point	Elevation of Measuring Point (feet-NGVD)	Elevation of Ground Surface (feet-NGVD)	Depth to Top of Bedrock (feet-bgs)	Elevation of Bedrock (feet-NGVD)	Screened (s) or Open Hole (o) Interval (feet-bgs)	Elevation Bottom of Open Interval (ft-NGVD)
MW-45S	TPVC (2-in)	178.95	175.99	--	--	13.5 - 18.5 (s)	157.49
MW-46S	TPVC (2-in)	178.69	175.64	--	--	16.5 - 21.5 (s)	154.14
MW-48S	TPVC (0.75-in)	163.57	161.60	--	--	6 - 8 (s)	153.60
MW-49S	TPVC (0.75-in)	164.23	162.60	--	--	13 - 15 (s)	147.60
MW-50S	TS (2-in)	169.98	167.90	--	--	14 - 16 (s)	151.90
RW-1	TPVC (6-in)	179.06	178.02	4.00	174.02	12 - 30 (o)	148.02
RW-2	TMC	177.54	177.01	5.00	172.01	4.5 - 29.5 (s)	147.51
RW-3	TMC	177.62	176.92	4.50	172.42	6 - 43.5 (s)	133.42
RW-4	TMC	177.82	177.04	11.00	166.04	7 - 34.5 (s)	142.54
RW-5	TPVC (6-in)	177.00	176.30	9.50	166.80	12 - 45 (o)	131.30
RW-7B1	TPVC (1.25-in)	176.76	175.97	23.00	152.97	25 - 55 (s)	120.97
RW-7B2	TPVC (1.25-in)	176.76	175.97	23.00	152.97	71 - 101 (s)	74.97
RW-8	TMC	177.51	176.45	16.50	159.95	11.5 - 217 (s)	-40.55
RW-9	TMC	177.28	175.81	17.50	158.31	12.5 - 27.5 (s)	148.31
RW-10	TMC	177.38	175.78	23.00	152.78	18 - 33 (s)	142.78
RW-11	TMC	177.48	176.11	28.00	148.11	23 - 38 (s)	138.11
RWS-1	TMC	168.02	167.32	19.00	148.32	15 - 55 (s)	112.32
RWS-2	TPVC (4-in)	171.85	170.01	19.50	150.51	15 - 79 (s)	91.01
RWS-3	TMC	169.40	168.19	19.50	148.69	15 - 55 (s)	113.19
RWS-4	TPVC (4-in)	171.28	168.57	19.00	149.57	15 - 55 (s)	113.57
RWS-5	TMC	168.16	167.35	18.50	148.85	16 - 66 (s)	101.35
RWS-6	TMC	168.03	167.23	15.50	151.73	14 - 111 (s)	56.23
RWS-7	TMC	172.10	171.42	23.00	148.42	26.5 - 51.5 (s)	119.92
RWS-8	TPVC (4-in)	174.29	172.12	18.92	153.20	9.92 - 24.92 (s)	147.20
IN-1B1	TPVC (1.25-in)	180.34	178.64	11.00	167.64	15 - 30 (s)	148.64
IN-1B2	TPVC (1.25-in)	180.36	178.66	11.00	167.66	81 - 96 (s)	82.66
IN-2B1	TPVC (1.25-in)	180.54	178.94	10.50	168.44	12 - 22 (s)	156.94
IN-2B2	TPVC (1.25-in)	180.57	178.97	10.50	168.47	100 - 110 (s)	68.97
IS-1S	TPVC (2-in)	166.32	163.97	--	--	7.0 - 13.0 (s)	150.97
IS-1B	TS (6-in)	165.07	163.97	16.00	147.97	17.1 - 115 (s)	48.97
IS-2S	TPVC (2-in)	171.92	169.13	--	--	10.0 - 20.0 (s)	149.13
IS-2B	TS (6-in)	170.40	169.40	23.00	146.40	25 - 130 (o)	39.40
IW-1B	TS (6-in)	183.39	182.89	9.00	173.89	10 - 113 (o)	69.89
IW-2B	TS (6-in)	184.22	183.12	13.00	170.12	15 - 118 (o)	65.12
IW-3B	TS (6-in)	181.95	181.45	8.00	173.45	9.5 - 108 (o)	73.45
IW-4B	TS (6-in)	181.09	179.99	5.00	174.99	7.5 - 108 (o)	71.99
IG-1S	TPVC (2-in)	180.01	177.70	--	--	4.0 - 6.0 (s)	171.70
IG-1D	TPVC (2-in)	180.03	177.60	--	--	10.0 - 20.0 (s)	157.60
IG-2S	TPVC (2-in)	180.99	178.70	--	--	4.0 - 6.0 (s)	172.70
IG-2D	TPVC (2-in)	181.15	178.70	--	--	10.0 - 20.0 (s)	158.70
VAN WART	TS (6-in)	173.13	171.78	29.00	142.78	39 - 142(o)	29.78
SMITH	TS (6-in)	174.55	173.35	--	--	30 - 421 (o)	

Notes:

1. Monitoring wells destroyed during NTCRA site work 1999: MW-7, and G-1 through G-6.

Abbreviations:

TPVC means top of PVC well casing (casing diameter in parentheses).
TS means top of steel casing (casing diameter in parentheses).
'- means no data.
bgs means below ground surface.
BMP means below measuring point.
TMC means top of manhole cover (Survey point is v-notch in manhole cover).

TABLE 2-2
DIRECT PUSH WELL CONSTRUCTION SUMMARY
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Northern Plume Direct Push Well Identification		Screened Interval Top and Bottom (feet-bgs)	
N	1-6	4.5	6.5
N	1-7	3.8	5.8
N	1-8	2.8	4.8
N	1-9	5.7	7.7
N	1-10	3.8	5.8
N	1-10A	3	5
N	1-11	5.4	7.4
N	12-89	4.6	6.6
N	2-4	6.7	8.7
N	2-5	7.15	9.15
N	2-6	5	7
N	2-7	4	6
N	2-8	3.7	5.7
N	2-9	4.8	6.8
N	2-10	7.1	9.1
N	2-11	9	11
N	3-2	12	14
N	3-3	9.5	11.5
N	3-4	8.2	10.2
N	3-6	3.3	5.3
N	3-7	3	5
N	3-8	5.5	7.5
N	3-9	4.5	6.5
N	3-10	8	10
N	3-11	4.5	6.5
N	3-12	4.8	6.8
N	4-1	12.5	14.5
N	4-2	11.2	13.2
N	4-3	9.4	11.4
N	4-5	8.5	10.5
N	4-8	9.2	11.2
N	4-9	2.5	4.5
N	4-10	9.4	11.4
N	4-11	8	10
N	4-12	5.3	7.3
N	4-13	4.5	6.5
N	5-2	12.1	14.1
N	5-3	9.1	11.1
N	5-4	9.9	11.9
N	5-5	7.4	9.4
N	5-6	8	10
N	5-7	3.9	5.9
N	5-8	6.75	8.75
N	5-10	8.3	10.3
N	5-10	19.5	21.5
N	5-11	5.4	7.4
N	5-12	3	5
N	5-13	4.9	6.9

Southern Plume Direct Push Well Identification		Screened Interval Top and Bottom (feet-bgs)	
S	1-7	15.5	17.5
S	2-4	11.7	13.7
S	2-5	11.4	13.4
S	2-6	16.4	18.4
S	2-7	14.8	16.8
S	2-8	18.9	20.9
S	23-67	15.5	17.5
S	23-78	16.4	18.4
S	3-3	15.6	17.6
S	3-4	13.7	15.7
S	3-5	14.4	16.4
S	3-6	14.5	16.5
S	3-7	14.5	16.5
S	34-62	16.8	18.8
S	34-78	14	16
S	34-89	4.5	6.5
S	34-910	7.5	9.5
S	4-3	17.7	19.7
S	4-4	14.5	16.5
S	4-5	13.3	15.3
S	4-6	14.8	16.8
S	4-7	14.1	16.1
S	4-8	15.3	17.3
S	45-34	12.5	14.5
S	45-56	16.5	18.5
S	45-78	15.4	17.4
S	5-4	17.2	19.2
S	5-5	13.5	15.5
S	5-6	14.7	16.7
S	5-7	14.7	16.7
S	5-8	16	18
S	6-1	13	15
S	6-6	13.4	15.4
S	6-7	14.5	16.5
S	6-8	11.5	13.5
S	6-8	12	14
S	7-1	15.1	17.1
S	7-2	19.1	21.1
S	8-1	17.7	19.7
S	8-3	19.5	21.5
S	8-4	16	18
S	89-23	18.1	20.1
S	9-1	17.7	19.7
S	9-2	18.5	20.5
S	9-3	18.5	20.5
S	9-4	17.1	19.1
S	9-5	15.5	17.5
S	910-23	18	20

Southern Plume Direct Push Well Identification		Screened Interval Top and Bottom (feet-bgs)	
S	10-2	18.5	20.5
S	10-3	15.5	17.5
S	10-5	10.2	12.2
S	1011-23	17.5	19.5
S	1011-45	10.5	12.5
S	11-2	18.1	20.1
S	11-3	17.8	19.8
S	1112-45	14	16
S	12-1	17.5	19.5
S	12-2	17.6	19.6
S	12-3	18	20
S	12-4	14.1	16.1
S	1213-34	15.5	17.5
S	13-1	15.7	17.7
S	13-2	17.6	19.6
S	13-3	17.7	19.7

Notes:
1) bgs means below ground surface.

TABLE 2-3
PHASE I PILOT STUDY FIELD ACTIVITIES– NORTHERN VOC PLUME
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Week 1 – July 16 – 22, 2000

- July 17th – Baseline field parameters measured in selected wells.
- July 18th – Finished baseline parameters. Sodium permanganate (NaMnO4) added to MW-34B and MW-35B1.
- July 19th - NaMnO4 observed in MW-20B, a shallow bedrock wells approximately 6 feet south of MW-35B1.
- July 20th – NaMnO4 added to IN-1B and IN-2B. NaMnO4 remaining in MW-20B. Other monitoring wells are clear.
- July 21st - NaMnO4 remaining in MW-20B. Other monitoring wells are clear.
- July 22nd – NaMnO4 remaining in MW-20B. Other monitoring wells are clear.

Week 2 – July 23 – 29, 2000

- July 23rd - No significant changes. NaMnO4 remaining in MW-20B. Other monitoring wells are clear.
- July 24th – MW-20B – color changed to brownish-orange. Other monitoring wells are clear.
- July 25th – MW-20B - color changed to less intense purple. Other monitoring wells are clear.
- July 26th – MW-20B changed to brownish-orange. Other monitoring wells are clear.
- July 27th – IN-1B changed from purple to orange-brown.
- July 28th - MW-20B changed to clear. IN-1B changed from orange-brown to purple. IN-2B – purple is fading. Other monitoring wells are clear.

Week 3 – July 30 – August 5, 2000

- No significant changes in extent of purple NaMnO4 based on observations at monitoring wells during this week.
- Aug. 2nd - Liquid sample collected from northern frac tank for analysis of NaMnO4. Groundwater levels measured in selected well throughout northern plume. Checked packers. MW-35B (0 psi), MW-36B (210 psi), MW-39B (205 psi), MW-40B (80 psi). MW-35B packer reinflated.
- Aug. 3rd - Groundwater levels measured in selected well throughout northern plume. Spectrophotometer results from Carus Chemical Company indicated 30 mg/L NaMnO4 residual.

TABLE 2-3 (CONT.)
PHASE I PILOT STUDY FIELD ACTIVITIES– NORTHERN VOC PLUME
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Week 4 – August 6 – 12, 2000

- Aug. 7th – No significant changes. Recirculation Plan Developed and distributed.
- Aug. 8th – Started adding to MW-20S, MW-28B and MW-29B. Addition discontinued overnight to avoid potential overtopping.
- Aug. 9th –Started adding water from southern frac tank (30 mg/L NaMnO4) to MW-20S (1.5 gpm), MW-28B (1 gpm) and MW-29B (0.25 gpm). At 5 PM, flow rates reduced at MW-20S (0.75 gpm) to prevent potential overtopping overnight.
- Aug. 10th – Flow stopped overnight in MW-20S and MW-29B. Flow continuous in MW-28B (1 gpm). At noon, flow rates adjusted slightly with MW-20S (1 gpm), MW-28B (1 gpm) and MW-29B (0.25 gpm). Set up temporary 2-carbon drum treatment system to treat water in northern frac tank and discharge treated water to infiltration gallery. Temporary system on. Effluent clear.
- Aug. 11th – No significant changes in field parameters. At noon, turned off addition to MW-20S, MW-28B and MW-29B over weekend to avoid potential overtopping. Turned off temporary treatment system.

Week 5 – August 13 –18, 2000

- Aug. 14th – Started temporary treatment system. Effluent clear. Run overnight.
- Aug. 15th – No significant changes in field parameters.
- Aug. 16th – Started pumping RW-2 (0.5 gpm), RW-3 (1 gpm), and RW-4 (1.5 gpm) into northern frac tanks.
- Aug. 17th – Added remaining 30 mg/L NaMnO4 water in southern frac tank into wells MW-3S (20 gal), MW-3B (20 gal), and MW-24B (45 gal). Water from northern frac tank overnight through temporary treatment system.
- Aug. 18th –Continued pumping RW-2 (0.5 gpm), RW-3 (1 gpm) and RW-4 (1.5 gpm) into northern frac tank. Groundwater levels and field parameters measured.

Week 6 – August 20 – 26, 2000

- Aug. 21 – Continued pumping of RW-2, 3 and 4.
- Aug. 22 – RW-2, 3 and 4 turned off. Approximately 30 gal of NaMnO4 laden groundwater pumped from RW-3 and added to MW-34B. Approximately 30 gal of groundwater containing NaMnO4 pumped from RW-4 and added to IN-2B.
- Aug. 23 – Approximately 66 gallons of NaMnO4 laden groundwater pumped from RW-3 and added to MW-34B. Approximately 66 gallons of groundwater containing NaMnO4 pumped from RW-4 and added to IN-2B. RWS-6 turned off and RWS-5 turned on.
- Aug. 24 –Groundwater containing NaMnO4 from RW-3 and RW-4 was added to MW-34B (90 gallons), and IN-2B (150 gallons), respectively.
- Nitrogen tank regulators indicated no air pressure in bladders in wells MW-35B and MW-39B.

- Aug. 25 –RW-4 turned on at 3 PM (3.5 gpm) and left on over weekend. Temporary carbon treatment of northern frac tank left on over weekend. Replaced nitrogen tank at MW-35B and inflated bladder to 200 psi.

Week 7 – August 27 – September 2, 2000

- Aug. 29th – RW-4 pumping continues through week. MW-34B contained pink NaMnO4 water and IN-2B contained dark pink. One nitrogen tank delivered and inflated packer at MW-35B. IN-1B groundwater was clear.
- Aug. 30th – Started pumping purple water from IN-2B to frac tank. (75 gallons removed when water turned from purple to brownish-orange). Temporary carbon treatment left on. Northern frac tank essentially empty. Purged 1 casing volume (approx. 100 gallons) of purple water from MW-34B. Stopped purging when color changed from dark pink to light pink. MW-24B is pink.
- Aug. 31st –MW-34B recharging. Northern frac tank connected to temporary two-carbon drum treatment system and discharging to infiltration gallery. Effluent remains clear. Three nitrogen tanks delivered and hooked up to MW-35B (losing 200 psi/day), MW-39B, and MW-40B.
- Sept. 1st – RW-4 pumping since Aug. 25th. (3-3.5 gpm est.) to try to promote migration of purple water in IN-2B to RW-4. Groundwater is pink in MW-24B, MW-34B and IN-2B. No other wells show NaMnO4. MW-34B recharged overnight and color changed from dark purple to pink. At end of day, RW-4 (3.5 gpm) turned off and temporary treatment system left on to treat 2.5 gpm from RWS-5 over the weekend.

Week 8 – September 5 – 9, 2000

- Sept. 6th- Post Phase I sampling started. Recovery wells and addition wells remain off. Temporary treatment system remained on during the weekend. MW-35B1 and B2 sampled before noon. MW-35B packer at 200 psi, tank at 1250 psi. Nitrogen leak at valve connection repaired.

TABLE 2-4
PHASE II PILOT STUDY FIELD ACTIVITIES– NORTHERN VOC PLUME
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Week 1 - April 30 - May 6, 2001

- April 30th – TtNUS held Field Orientation Meeting with IT and Yarmouth Drilling. Yarmouth begins drilling direct push wells (application/monitoring points). IT performs application test with water only in the N1 row. All sodium permanganate ($NaMnO_4$) solution will be added into the aquifer under (approximately 30-40 psi). The concentration range of $NaMnO_4$ will be 1% to 20% After the $NaMnO_4$ is added, water will be added under pressure into the aquifer to help disperse the $NaMnO_4$. Application test is completed successfully. Baseline field parameters are measured in selected wells. Water from the recovery wells is being pumped into north frac tank. From the north frac tank the water is being pumped into a filter, to remove suspended solids, then into two carbon units in series, and then into wells IW-1B, IW-2B, IW-3B and IW-4B were it was added into the bedrock aquifer.
- May 1st - Finished baseline round for field parameters. $NaMnO_4$ solution followed by water is added to N1-8, N1-9, and N1-10.
- May 2nd - Monitored wells down gradient to the injection points from the previous day. No significant changes in field parameters or color were observed. $NaMnO_4$ solution followed by water is added to N1-6, N1-7, N1-11, and N2-4.
- May 3rd – Monitored wells down gradient to the previous injection points. No significant changes in field parameters or color observed. $NaMnO_4$ solution followed by water is added to N2-6 through N2-11. Monitored wells down gradient to row N2. No significant changes in field parameters or color observed. $NaMnO_4$ solution followed by water is added to N3-7 through N3-12.
- May 4th – Repeated monitoring of same baseline wells. No significant changes in field parameters or color observed.
- May 5th- Monitored injection points down gradient to the last injection points. No significant changes in field parameters or color were observed.

Week 2 - May 07 - May 13, 2001

- May 7th - Liyang Chu and Ed Hathaway onsite. $NaMnO_4$ solution followed by water is added to N3-6 and N3-7.
- May 8th - Liyang Chu and Ed Hathaway onsite. $NaMnO_4$ solution followed by water is added to N3-3 through N3-5, and N4-8 through N4-13.
- May 9th- $NaMnO_4$ solution followed by water was added to N4-1 through N4-3. Monitored injection points down gradient to the last injection points. No significant changes in field parameters or color observed. $NaMnO_4$ solution and water is added to N4-9, N4-13, and N5-11 through N5-13. Monitored recovery well manifold for purple – purple observed. However with no isolation valves it could not be determined which well(s) specifically was pumping $NaMnO_4$. Monitored the following wells for color: MW-3B (dark purple), MW-23S (clear), MW-23M (clear), MW-30 (clear), MW-41B (clear), MW-44B (clear), and MW-43B (clear).
- May 10th – Installed sample ports at extraction wells. RW-2 was noted to be pumping light pink. $NaMnO_4$ was added to wells N5-6 and N5-5. Stopped $NaMnO_4$ addition to adjust pump depths. What are the adjusted depths? and monitored midpoints in the direct push wells. 10

of 15 midpoints were dry. Of the remaining 5 midpoints no significant changes in field parameters or color were observed. $NaMnO_4$ solution added to N5-1 through N5-4. Monitored the following wells for color: MW-20B, MW-28B1, MW-28B2, MW-29B1, MW-29B2, MW-34B1, MW-34B2, MW-35B, MW-36B1, MW36B2, IN-1B1, IN-1B2, IN-2B1, and IN-2B2. MW-3B still is dark purple in color.

Week 3 - May 14 - May 20, 2001

- May 14th - IT added diluted solution of $NaMnO_4$ into the northern plume.
- May 15th – IT continues to inject diluted solution of $NaMnO_4$ into the northern plume, then begins to monitor field parameters in the following wells: N34-89, N34-910A RW-3, RW-4, RW-8, MW23B, and RW5.
- May 16th – Monitored for field parameters in the following wells: MW23B, N34-89, N34-910A, RW-3, RW-4, RW-5, and RW-8. $NaMnO_4$ followed by water added to the following wells: N12-67, N12-78, N12-89, N12-910, N23-45, N23-56, N23-67, N23-78, N23-89, N23-910, N23-1011, and N23-1112. Also checked recovery wells for color. RW-11 was pink in color. Monitored the following wells for field parameters: IN1-B1, MW-23B, MW29-B1, MW29-B2, MW-39B, N34-87, N34-1011, RW-3, RW-4, RW-5, RW-8, and RW-9. Yarmouth finishes drilling today.
- May 17th – IT monitors field parameters in the following wells: IN1-B1, MW23-B, MW29-B1, MW29-B2, MW-39B, RW-3, RW-4, RW-5, RW-8, RW-9, N34-87, and N34-1011. $NaMnO_4$ and water added to midpoints of rows 3 and 4.

Week 4 - May 21 - May 27, 2001

- May 21st - Monitor recovery wells for color - no color observed.
- May 22nd -Perform water level round in all northern plume wells and monitor field parameters in all baseline wells, including all recovery wells and some mid points. No purple observed in recovery wells.
- May 23rd – 23 points were injected (flushed) with water today in rows N1and N2. Also check for color in recovering wells - no color observed in recovery wells.
- May 24th – N1, N2, N3, N4 row all flushed with water. Monitor field parameters and color in recovery wells. No color observed in recovery wells.
- May 25th – Monitor recovery wells for color, no color observed in recovery wells.

TABLE 2-5
PHASE I PILOT TEST STUDY - SODIUM PERMANGANATE APPLICATION SUMMARY NORTHERN VOC PLUME
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Date	Well ID	NaMnO4 Added (gal)	NaMnO4 (%)
First Addition			
07/18/00	MW-34B	2	20
07/18/00	MW-35B1	2	20
07/20/00	IN-1B	2	20
07/20/00	IN-2B	2	20
Second Addition			
Sep-00	MW-34B	0.5	20
	MW-35B	4	20
	IN-1B	1	20
	IN-2B	0.5	20
	MW-20B	3	20
Third Addition			
Jan-01	MW-34B1	6	40
	MW-35B1	8.5	40
	MW-35B2	8.5	40
	IN-1B	4	40
	IN-2B	4	40
	MW-20B	4	40

TABLE 2-6
PHASE II PILOT TEST STUDY SODIUM PERMANGANATE APPLICATION SUMMARY NORTHERN VOC PLUME
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Date	Well ID	NaMnO4 Added (gal)	NaMnO4 (%)	Water Added (gal)
5/1/2001	N1-9	16	20	16
5/1/2001	N1-8	16	20	16
5/1/2001	N1-10	8	20	16
5/2/2001	N1-7	16	20	16
5/2/2001	N1-6	16	20	16
5/2/2001	N2-4	35	20	0
5/2/2001	N1-11	3	20	0
5/3/2001	N2-11	16	20	4
5/3/2001	N2-10	20	20	20
5/3/2001	N2-9	16	20	16
5/3/2001	N2-8	16	20	16
5/3/2001	N2-7	16	20	16
5/3/2001	N2-6	16	20	16
5/4/2001	N3-12	16	20	16
5/4/2001	N3-11	28	20	28
5/4/2001	N3-10	40	20	40
5/4/2001	N3-9	28	20	28
5/4/2001	N3-8	28	20	28
5/4/2001	N3-7	15	20	0
5/7/2001	N3-7	5	20	1
5/7/2001	N3-6	16	20	16
5/8/2001	N3-5	16	20	16
5/8/2001	N3-4	16	20	16
5/8/2001	N3-3	16	20	16
5/8/2001	N4-13	2	20	0
5/8/2001	N4-12	18	20	14
5/8/2001	N4-11	28	20	28
5/8/2001	N4-10	40	20	40
5/8/2001	N4-9	40	20	0
5/8/2001	N4-8	28	20	28
5/9/2001	N4-3	16	20	16
5/9/2001	N4-7	16	20	16
5/9/2001	N4-1	16	20	16
5/9/2001	N5-12	16	20	0
5/9/2001	N5-11	28	20	28
5/9/2001	N4-9	0	20	14
5/9/2001	N5-13	16	20	16
5/10/2001	N5-6	14	10	0
5/10/2001	N5-5	14	10	0
5/10/2001	N5-4	14	10	0
5/10/2001	N5-3	15	10	0
5/10/2001	N5-2	16	10	0
5/10/2001	N5-1	16	10	0
5/16/2001	N12-67	0	1	20
5/16/2001	N12-78	0	1	20
5/16/2001	N12-89	20	1	20
5/16/2001	N12-910	0	1	20
5/16/2001	N23-1112	25	1	25
5/16/2001	N23-1011	25	1	25
5/16/2001	N23-910	25	1	25
5/16/2001	N23-89	10	1	0
5/16/2001	N23-78	25	1	25
5/16/2001	N23-67	0	1	0
5/16/2001	N23-56	0	1	0
5/16/2001	N23-45	25	1	25

TABLE 2-7
PHASE I PILOT STUDY FIELD ACTIVITIES– SOUTHERN VOC PLUME
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Week 1 – July 16 to July 22, 2000

- July 17th – Packer in MW-8B deflated from 30 PSI to 0 psi for Pilot Test. Baseline field parameters measured in selected wells. Setup discharge lines from RWS-3, 5, 6 to southern frac tank.
- July 18th – Finished baseline field parameters. Sodium permanganate (NaMnO4) added to overburden wells MW-8S, MW-33S and IS-2S, bedrock wells MW-8B and IS-2B, and in recovery well RWS-6.
- July 19th - NaMnO4 observed in RWS-5, a recovery well screened across both the overburden and bedrock and located approximately 15 feet downgradient of MW-33S.
- July 20th – NaMnO4 observed in IS-1B. Started pumping RWS-5.
- July 21st - RWS-5 pump shut down overnight. Restarted RWS-5 (2 gpm) and discharge into the southern frac tank. No other significant changes in color.
- July 22nd – IS-1B – slight decrease in purple. Other monitoring wells are clear. Continued pumping RWS-5 (2 gpm) to southern frac tank.

Week 2 – July 23 to July 29, 2000 –

- July 23rd – Continued pumping RWS-5 (2 gpm).
- July 24th – Continued pumping RWS-5 (2 gpm). RWS-5 shows decreased intensity of purple. Started pumping RWS-3 (2.5 gpm) to southern frac tank. Water from southern frac tank added to IS-2S (2.5 – 3 gpm). Started addition to MW-33S. Addition reduced at IS-2S (1.8 gpm). Purple NaMnO4 not observed in other wells. Ceased pumping RWS-3 and ceased addition overnight at both IS-2S and MW-33S to avoid potential overtopping of addition wells.
- July 25th – Continued pumping of RWS-3 and RWS-5. Started addition to MW-18S from RWS-5. RWS-6 added at noon and pumped overnight. Continued addition to IS-2S and MW-33S. Slight increase in purple at IS-1B. Stopped pumping of RWS-5 at 6:30 PM to conserve storage capacity.
- July 26th –Continued pumping RWS-6 (2 gpm) into southern frac tank. Continued addition to MW-18S (1.5 gpm) from RWS-5. IS-1B remains purple.
- July 27th – Continued addition to MW-18S (2-3 gpm) from RWS-5. Connected 1-in. diameter pipe between main discharge line (at RWS-7 manhole) to northern frac tank. Discharging 0.5 gpm to northern frac tank.
- July 28th – Continued pumping RWS-5 (3 gpm), addition to MW-18S (2.5 gpm) and addition to northern frac tank (0.5 gpm).

TABLE 2-7 (cont.)
PHASE I PILOT STUDY FIELD ACTIVITIES– SOUTHERN VOC PLUME
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Week 3 – July 30 to August 5, 2000

- July 30th to Aug. 1st - Continued pumping RWS-5 (3-3.5 gpm), addition at MW-18S (3 gpm), and remainder to northern frac tank. Color of addition water is light pink. IS-1B groundwater is fainter. NaMnO4 not observed in other wells.
- Aug. 2nd - Liquid sample collected from southern frac tank for analysis of NaMnO4.
- Aug. 3rd - Continued pumping RWS-5 (2 gpm est.). Spectrophotometer results from Carus Chemical Company indicated 3.4 mg/L NaMnO4 residual.

Week 4 – August 6 – 12, 2000

- Aug. 7th – RWS-5 pumping (2 gpm). Recirculation Plan Developed and distributed.
- Aug. 8th – Add two additional sump pumps to southern frac tank and connect one to main discharge line (at RWS-3 manhole) and the other connected to MW-9S (2 gpm). Pump through to northern frac tank. Adding to MW-9S (2 gpm) during the day but stopped overnight to avoid potential overtopping.
- Aug. 9th –11th -Continued pumping RWS-5 (2 gpm) and adding to both MW-9S (1 gpm) and MW-18S (2 gpm).

Week 5 – Aug 13 –18, 2000

- Aug. 14th – Continued pumping RWS-5 (2 gpm) and adding to both MW-9S (1 gpm) and MW-18S (2 gpm).
- Aug. 15th – Continued pumping RWS-5 (2 gpm) and adding to both MW-9S (1 gpm) and MW-18S (2 gpm). Started adding to MW-22B (1 gpm) from southern frac tank.
- Aug. 16th – Continued pumping RWS-5 (2 gpm) and adding to MW-9S (1 gpm), MW-18S (2 gpm), and MW-22B (1 gpm). Started adding to MW-25S (1 gpm) from tie into line at MW-18S (frac tank mixed with water pumped from RWS-5).
- Aug. 17th – Continued pumping RWS-5 (2 gpm) and adding to MW-9S (1 gpm), MW-18S (2 gpm), MW-22B (1 gpm) and MW-25S (1 gpm). Started pumping RWS-3 and RWS-6 (6 gpm combined) and stopped pumping RWS-5. Southern frac tank emptied at noon which ended addition at both MW-9S and MW-22B. Water in RWS-3 is light pink.
- Aug. 18th –Continued pumping RWS-6 (3 gpm) to southern frac tank. Groundwater light pink in RWS-6 and clear in RWS-3. Stopped pumping RWS-3. Stopped addition to upgradient wells (MW-18S and MW-25S). Groundwater levels and field parameters measured before addition terminated.

Week 6 – August 20 - 26

- Aug. 21 – Continued pumping RWS-6.
- Aug. 22 –Added approx. 2 well columns to MW-8S from RWS-6. Added 2 well column to IS-2B from RWS-6.

- Aug. 23 – IS-1B (downgradient of extraction wells) clear for first time since addition was initiated in upgradient wells (July 18th). Started pumping RWS-5 (2-3 gpm) and stopped RWS-6.
- Aug. 24 – NaMnO4 laden groundwater added to MW-8S (1 water col), and IS-2B (1 water col).
- Aug. 25 – Continued pumping RWS-5 (2-3 gpm) and through weekend. Temporary carbon treatment of northern frac tank continued operation through weekend.

Week 7 – August 27 – September 2, 2000

- Aug. 29th – Continued pumping RWS-5 (2-3 gpm). Objective to purge residual NaMnO4 from addition wells that contain purple NaMnO4 to allow time for wells to equilibrate with the groundwater system. Started purging MW-8S and IS-2B.
- Aug. 30th – Continued pumping RWS-5 (2-3 gpm). Purged 200 gallons of water from IS-2B to frac tank. IS-1B and MW-8S are pink. IS-2B and RWS-5 are purple.
- Aug. 31st – Groundwater in IS-2B changed color from dark pink to bright pink. IS-1B and MW-8S are light pink.
- Sept. 1st – No significant changes in color. RWS-5 pumping (2.5 gpm) continued over weekend to northern frac tank. Temporary treatment system that discharges to the interceptor trench left on. Effluent clear. Southern frac tank sump pumps turned off over weekend.

Week 8 – September 5 – 9, 2000

- Sept. 6th- Post Phase I sampling started. Pumping RWS-5 (3 gpm) to northern frac tank, which is then treated and discharged to the infiltration gallery

TABLE 2-8
PHASE I PILOT TEST STUDY SODIUM PERMANGANATE APPLICATION SUMMARY
SOUTHERN VOC PLUME
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Date	Well ID	NaMnO4 Added (gal)	NaMnO4 (%)
First Addition			
07/18/00	MW-8S	6	20
07/18/00	MW-33S	6	20
07/18/00	IS-2S	6	20
07/18/00	IS-2B	6	20
07/18/00	MW-8B	6	20
07/18/00	RWS-5	6	20

TABLE 3-1
BOREHOLE GEOPHYSICAL LOGGING SUMMARY
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Well ID	Total Depth (feet-btoc)	Depth of Casing (feet-btoc)	Depth to Groundwater (feet-btoc)	Caliper Log Depth (feet-btoc)	Gamma Log (>15 cps) Depth (feet-btoc)	Flowmeter Log	Acoustical Televiewer Log: Fracture Numbers	Dip	Dip Direction	Strike	Comments
NORTHERN PLUME AREA											
MW-34B	72	13	9	12 - 17		?	1	LOW	W	S	Most transmissive fractures at 12-17 ft and 60-62 ft. Upflow under ambient and pumping (RW-2, -3, -4) conditions. Upflow to shallow fractures increased when RW-2, -3, -4 were operating. Most of the increase in upflow from 60-62 ft occurred within 90 minutes of activation of RW-2, -3, -4.
				17 - 20		enters	2 & 3	MOD	SW	SE	
				37 - 40		exits	19 & 20	LOW	SE	NE	
				50 - 55	53 - 57	exits	33 & 35	LOW	NW	SW	
							32 & 34	LOW	NE	NW	
				60 - 62		enters	40	LOW	NE	NW	
					65 - 70						
MW-35B	106/66	9	8	9.5		exits	--	--	--	--	When borehole open to 106 ft, most upflow entered at 9.5 ft, 13 ft, 15 ft and 20-21 ft and exited through fractures below 90 ft, principally through a fracture at 106 ft. Operation of RW-2, -3, -4 decreased head and downflow in borehole. Grouted borehole to 66 ft., and installed 4-inch PVC well screened from 7 to 67 ft. When borehole open to 67 feet, flowmeter logging performed while pumping 0.75 gpm from MW-35B. The flowmeter results indicated water entered at 60-65 ft, 35-40 ft, 15-20 ft and exits at 45-50 ft and 13-15 ft.
				13		enters	1	MOD	NE	NW	
				15			2	HIGH	W	S	
				20-21		enters	5	MOD	NE	NW	
					60-64						
					70-73						
					85-88						
				96			41	HIGH	SW	SE	
				97			42	MOD	NE	NW	
				98.6	99-106		43 & 44	LOW	SW	SE	
				101.1			45 & 46	LOW	SW	SE	
				101.5			47	LOW	SW	SE	
				102.5			48	LOW	NW	SW	
				105		exits	49	HORIZ.	NA	NA	
MW-36B	144	11	4	12		exits	--	--	--	--	While pumping RW-2, -3, -4, a minor upflow entered the borehole through a fracture at 23 ft, and exited through a fracture at 12 ft immediately below the casing.
				14							
				16	16-25						
				21							
				23		enters	7	HIGH	SW	SE	
					57-61						
					63-65						
					67-69						
MW-37B	100	26	11.5	27	-	--	--	--	--	--	Minor upflow of water entered through a fracture at 74 ft and exited through a fracture at 31 ft.
				29							
				31		exits	-				
				74		enters	21	MOD	NW	SW	
MW-39B (1)	216	17	19.4								While pumping at less than 0.5 gpm, water entered through fractures at 67-70 ft and 95 - 100 ft and exited through fractures at 40-48 ft.
				40-48		exits	7	HIGH	NE	NW	
				67-70		enters	15	HIGH	N	W	
							16	MOD	SE	NE	
				95-100		enters	33	HIGH	S	E	
							34	LOW	NW	SW	

TABLE 3-1 (CONT.)
BOREHOLE GEOPHYSICAL LOGGING SUMMARY
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE
PAGE 2 OF 5

	Total Depth	Depth of Casing	Depth to Groundwater	Caliper Log	Gamma Log (>15 cps)		Acoustical Televiewer Log				
Well ID	(feet-btoc)	(feet-btoc)	(feet-btoc)	Depth (feet-btoc)	Depth (feet-btoc)	Flowmeter Log	Fracture Numbers	Dip	Dip Direction	Strike	Comments
MW-40B (2)	220	23	19.6		23	enters	--	--	--	--	Under ambient conditions, downflow occured and water entered below the casing at 23 ft, exited at 52-53 ft, entered at 80 ft, exited and exited at 117-123 ft, 139-144 ft and 150-155 ft. While pumped at 0.5 gpm, upflow was induced and water entered through fractures at 139-144 ft, 47-48 ft, 52-53 ft and below the casing at 23 ft.
				47-48	40-50	enters	5	HIGH	SW	SE	
				52-57		exits	8-11	HIGH	SW	SE	
				80		enters	22	MOD	NW	SW	
				116-123		exits	34-37	MOD	NW	SW	
				139-144		exits	44	HIGH	NE	NW	
							45	HIGH	SE	NE	
MW-41B	205.7	10	7.9	10-20	Gamma log averaged 8 cps. Several depth intervals showed >10 cps, but none corresponded to caliper.	Flowmeter log indicated variable flow probably influenced by operation of extraction system.	1	MOD	SW	SE	Temperature log indicated transmissive fractures at 30 ft. Resistivity log indicated transmissive fractures at 160-170 ft. Flowmeter log effected by nearby extraction well pumping. ATV logging stopped at 116 ft where a rock protruded in borehole.
							2	MOD	N	W	
							9	HIGH	NE	NW	
				99.6			27	MOD	NW	SW	
				109			34	HIGH	NE	NW	
				114			36	LOW	NW	SW	
				129			--	--	--	--	
				151			--	--	--	--	
				162.3			--	--	--	--	
				165			--	--	--	--	
				167			--	--	--	--	
MW-42B	217.8	18	12	20	15-36	enters	1	LOW	SE	NE	Temperature log indicated water enters 12-34 ft and at 213 ft. Resistivity log indicated transmissive fracture at 118 feet. Flowmeter log indicated water enters below the casing at 18-32 ft and exits at 63.5 ft, 116-118 ft, and 128.5 to 130 ft.
				23		enters	3, 4	MOD	SE	NE	
				29, 31		enters	5	MOD	SE	NE	
				43	43	exits	8	LOW	SW	SE	
				63.5	69	exits	11	MOD	N	W	
				106		exits	18	LOW	NW	SW	
				108		exits	19	HIGH	NE	NW	
				117		exits	23	MOD	SW	SE	
				118		exits	24	HIGH	SW	NW	
MW-43B	222.7	21	11.75	22 - 25		enters	--	--	--	--	Flowmeter indicated water enters at 18-25 feet and exits at 104 feet.
					36 - 48						
					49 - 52						
				104		exits	26	LOW	NW	SW	
					175 - 186						
					191 - 222						

TABLE 3-1 (CONT.)
BOREHOLE GEOPHYSICAL LOGGING SUMMARY
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE
PAGE 3 OF 5

	Total Depth	Depth of Casing	Depth to Groundwater	Caliper Log	Gamma Log (>15 cps)		Acoustical Televiewer Log				
Well ID	(feet-btoc)	(feet-btoc)	(feet-btoc)	Depth (feet-btoc)	Depth (feet-btoc)	Flowmeter Log	Fracture Numbers	Dip	Dip Direction	Strike	Comments
IN-1B	111	13.5	9.5	14-18		enters	--	--	--	--	While IN-1B pumped at 0.7 gpm inside the casing, most water entered the borehole through shallow fractures beneath the casing at 14-21 ft, and from fractures at 92-93 ft and at 107 ft. Water exited through fractures at 41-43 ft, 74-76 ft and at 87 ft.
				19		exits	1	LOW	SW	SE	
							2	HIGH	S	E	
				21		exits	3	LOW	SW	SE	
							4	MOD	N	W	
				32 - 35		enters	8, 9, 10	MOD-HIGH	S-SW	E-SE	
				40 -45		exits	14, 15, 16	HIGH	NE	NW	
				74 - 83	54 - 110	exits	27, 29	LOW	NE	NW	
						exits	28	HIGH	SE	NE	
						exits	30	MOD	SE	NE	
				87		exits	31	MOD	NE	NW	
				92		enters	32	MOD	NE	NW	
				93		enters	33	LOW	SW	SE	
				106		enters	34	LOW	NE	NW	
				107		enters	35	MOD	N	W	
IN-2B	111	12	9.7	12-15	10-13	enters	1	LOW	NW	SW	While IN-2B pumped at 1.1 gpm, upflow induced and most water entered through fractures at 12-18 ft and at 30 - 33 ft.
				30		enters	6	MOD	NE	NW	
				33	33-40	enters	7	MOD	NW	SW	
					76-95		--	--	--	--	
					109		23-28	MOD	SW	SE	
RW-8	222.7	21	9.4	21-25	Gamma log averaged over 9 cps. Several depth intervals showed >10 cps, but none corresponded to caliper.	enters	--	--	--	--	Under ambient conditions, minor downflow in the middle of the boring and water entered through fractures at 55 ft, 81 ft, 102-103, 105 ft and exited through fractures at 110-114 ft. While RW-8 pumped at 0.35 gpm, upflow induced and most flow entered below the casing at 20-23 feet and at 43-50 ft. Temperature log indicated water entered between 9.4 and 40 ft and at 53 ft. Resisitivity log indicated potential transmissive fractures at 50, 102-103, 140 and 180 ft.
				32		enters	3,4	LOW-HIGH	NW	SW	
				46		enters	11	MOD	SW	SE	
				50		enters	12	MOD	SW	SE	
				65		enters	18, 19	HIGH-MOD	S	E	
				81		enters	22	MOD	SE	NE	
				102		enters	36	MOD	W	S	
				102.5		enters	37	MOD	NE	NW	
				103		enters	38	MOD	SE	NE	
				110		enters	40	MOD	NE	NW	
				111		enters	41	MOD	NE	NW	
				114		enters	43, 44	MOD	SW	SE	

TABLE 3-1 (CONT.)
BOREHOLE GEOPHYSICAL LOGGING SUMMARY
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE
PAGE 4 OF 5

Well ID	Total Depth (feet-btoc)	Depth of Casing (feet-btoc)	Depth to Groundwater (feet-btoc)	Caliper Log Depth (feet-btoc)	Gamma Log (>15 cps) Depth (feet-btoc)	Flowmeter Log	Acoustical Televiewer Log: Fracture Numbers	Dip	Dip Direction	Strike	Comments
IW-1B	110.1	9	13.6	9-24	Gamma log about 6 cps except 106-110 ft (6-11 cps).	enters	--	--	--	--	While IW-1B pumped at 0.3 gpm, upflow induced and most water entered below the casing and from a fracture at 96 ft. No measurable flow under ambient conditions.
				25-26		exits	4,5	MOD	SW & W	SE & S	
				43-46		enters	12,13	MOD-HIGH	SW	SE	
				47		enters	14	HIGH	SE	NE	
				96		enters	27	MOD	S	E	
IW-2B	116.6	15	14.2	15.5		enters	--	--	--	--	While IW-2B pumped at 0.3 gpm, upflow induced and most water entered at fractures beneath casing at 15-23 ft, at 75 ft, and at 106 ft. Minor flow entered at 37 ft, 42 ft, and exited at 57 ft. No measureable flow under ambient conditions.
				23		enters	1	HIGH	SW	SE	
				29-35		enters	2,3,4,5,6	MOD	SW	SE	
				37		enters	7	MOD	W	S	
				42		enters	12	MOD	SW	SE	
				57		exits	17	MOD	SW	SE	
				75		enters	21	MOD	SW	SE	
				106	94-116	enters	27	MOD	S	E	
IW-3B	106.3	9.5	12	10		enters	--	--	--	--	While IW-3B pumped at 0.25 gpm, upflow induced and most flow entered at 10-22 ft, 26-31 ft, 37-43 ft, 51 ft, and 78 ft. Temperature log generally supported flowmeter results. No measureable flow at ambient conditions.
				18.5		enters	1	HIGH	NE	NW	
				22		enters	2	HIGH	SE	NE	
				24		enters	3,4	LOW-HIGH	S-SE	E-NE	
				29		enters	5,6	LOW-HIGH	S-SE	E-NE	
				34		enters	7	MOD	SE	NE	
				51		enters	8	LOW	SW	SE	
				72-74	77-83	enters	15,16	LOW	NW	SW	
					91-96, 102	--	--	--	--	--	
IW-4B	106.9	26.5	10.3	9-14		enters	--	--	--	--	While IW-4B pumped at 0.25 gpm downflow induced and all flow entered at 10-25 ft and exited at 25-30 ft. No measureable flow under ambient conditions.
				15		enters	1	MOD	SE	NE	
				16.3		enters	2	LOW	S	E	
				19		enters	3	LOW	SE	NE	
				28.5-30		exits	4,5	MOD	SW	SE	
					67-70	--	18	MOD	N	W	
					92-106	--	--	--	--	--	

TABLE 3-1 (CONT.)
BOREHOLE GEOPHYSICAL LOGGING SUMMARY
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Well ID	Total Depth (feet-btoc)	Depth of Casing (feet-btoc)	Depth to Groundwater (feet-btoc)	Caliper Log Depth (feet-btoc)	Gamma Log (>15 cps) Depth (feet-btoc)	Flowmeter Log	Acoustical Televiewer Log: Fracture Numbers	Dip	Dip Direction	Strike	Comments
SOUTHERN PLUME AREA											
IS-1B	116	19	7.1	19-22		enters	--	--	--	--	
				29.5	--	enters	2-6	LOW	W-N	S-W	
				38-39.4		enters	10-11	LOW	SE	NE	While IS-1B pumped at 1.2 gpm, upflow induced and water entered at 19-22 ft, 28-31 ft, 38-39.4 ft, 68 ft, and at 90 ft. Water exited at 62 ft No measureable flow under ambient conditions.
							12	LOW	SW	SE	
							13	LOW	NW	SW	
				62		exits	20	HIGH	NE	NW	
				68		enters	22	HIGH	SE	NE	
				90.5		enters	29	MOD	NW	SW	
IS-2B	130.3	26.5	12.5	27		enters	1	MOD	W	S	
				30		enters	2	HIGH	NE	NW	
				40		enters	5-6	LOW	SW	SE	
				40	--	enters	7-8	LOW	NW	SW	While IS-2B pumped at 0.3 gpm, upflow induced and most water entered boring at 27 ft, 29-33 ft, 40 ft and at 102-106 ft. No measureable flow under ambient conditions.
				102		enters	33	MOD	NE	NW	
				104		enters	34	MOD	SE	NE	
				105		enters	35-36	LOW	NW	SW	
				106		enters	37	MOD	S	E	
NON-PLUME AREA											
SMITH WELL	421.4	31	32.9	38-40		enters	1, 5	MOD	W	S	
				42.5		enters	7	LOW	E	N	
				43		enters	8	HIGH	N	W	Resistivity log indicted potential transmissive fractures at 87 and 125 ft. While pumping the well at less than 0.05 gpm, flowmeter log indicated most flow entered borehole at 38-45 ft.
				57		--	14	MOD	SW	SE	
				65.7	67	--	18	HIGH	N	W	
				87		enters	36	MOD	NW	SW	
				125		--	48	MOD	W	S	

Notes
* means relatively more transmissive. LOW means dip angle ranges 0-33 degrees; MOD means dip angle ranges 34-67 degrees; high means 68-90 degrees.
1) Ambient flow meter logging performed in MW-39B under rising-head conditions a few days after this well drilled.
2) Ambient flowmeter logging performed in MW-40B under falling-head conditions a few days after this well drilled.
N, S, E, W means north, south, east and west, respectively.
NA means not applicable.

TABLE 3-2
NORTHERN PLUME EXTRACTION WELLS
PRE- JULY 2000 VOCS AND METALS DATA
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Sample Station			RW-2		RW-2		RW-2		RW-2		RW-2		RW-3		RW-3		RW-3		RW-3	
Sample Number			ES-GS-RW2-030100		ESGW-RW2		ES-GW-RW2		ES-RW-2-1112		ES-RW-2-03		ES-GS-RW3-030100		ESGW-RW3		ES-GW-RW3		ES-RW-3-2930	
Date Sampled			3/1/2000		5/10/2000		6/8/2000		1/28/1999		6/13/1999		3/1/2000		5/10/2000		6/6/2000		1/26/1999	
QC Identifier			None		None		None		Field Dup. ES-RW-2-1112		None		None		None		None		None	
Criteria	MCL	MEG 1992																		
Volatile Organic Analysis (UG/L)			D00295		ARC88		A00HY		DAHP77		DAHU15		D00296		ARC89		A00HX		DAHP80	
1,1,1,2-Tetrachloroethane		70		NA		NA		NA		NA		NA		NA		NA		NA		NA
1,1,1-Trichloroethane	200	200	1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
1,1,2,2-Tetrachloroethane			1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
1,1,2-Trichloro 1,2,2-trifluoroethane				NA	10	U	200	U		NA		NA		NA	50	U	10	U		NA
1,1,2-Trichloroethane	5	3	1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
1,1-Dichloroethane		*70*	*1*	*U*	*10*	*U*	*200*	*U*	*44*	*U*	*10*	*U*	*56*	*U*	*50*	*U*	*10*	*U*	*220*	*U*
1,1-Dichloroethene	7	7	1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
1,1-Dichloropropene				NA		NA		NA		NA		NA		NA		NA		NA		NA
1,2,3-Trichlorobenzene				NA		NA		NA		NA		NA		NA		NA		NA		NA
1,2,3-Trichloropropane		40		NA		NA		NA		NA		NA		NA		NA		NA		NA
1,2,4-Trichlorobenzene	70	70		NA	10	U	200	U		NA		NA		NA	50	U	10	U		NA
1,2,4-Trimethylbenzene				NA		NA		NA		NA		NA		NA		NA		NA		NA
1,2-Dibromo-3-chloropropane	0.2	0.2		NA	10	U	200	U		NA		NA		NA	50	U	10	U		NA
1,2-Dibromoethane				NA	10	U	200	U		NA		NA		NA	50	U	10	U		NA
1,2-Dichlorobenzene	600			NA	10	U	200	U		NA		NA		NA	50	U	10	U		NA
1,2-Dichloroethane	5	5	1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
1,2-Dichloroethene (total)	70	70	0.86	J		NA		NA	44	U	9	J	56	U		NA		NA	220	U
1,2-Dichloropropane	5	5	1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
1,3,5-Trimethylbenzene				NA		NA		NA		NA		NA		NA		NA		NA		NA
1,3-Dichlorobenzene		85		NA	10	U	200	U		NA		NA		NA	50	U	10	U		NA
1,3-Dichloropropane				NA		NA		NA		NA		NA		NA		NA		NA		NA
1,4-Dichlorobenzene	75			NA	10	U	200	U		NA		NA		NA	50	U	10	U		NA
2,2-Dichloropropane				NA		NA		NA		NA		NA		NA		NA		NA		NA
2-Butanone		170	10	U	10	U	200	U	44	U	10	U	560	U	50	U	10	U	220	U
2-Chlorotoluene				NA		NA		NA		NA		NA		NA		NA		NA		NA
2-Hexanone			10	U	10	U	200	U	44	U	10	U	560	U	50	U	10	U	220	U
4-Chlorotoluene				NA		NA		NA		NA		NA		NA		NA		NA		NA
4-Methyl-2-Pentanone			10	U	10	U	200	U	44	U	10	U	560	U	50	U	10	U	220	U
Acetone			10	U	10	U	200	U	44	U	1	JB	560	U	50	U	10	U	220	U
Benzene	5	5	0.17	J	10	U	200	U	44	U	10	U	*56*	*U*	*50*	*U*	*10*	*U*	*220*	*U*
Bromobenzene				NA		NA		NA		NA		NA		NA		NA		NA		NA
Bromochloromethane		92		NA		NA		NA		NA		NA		NA		NA		NA		NA
Bromodichloromethane	80		1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
Bromoform	80		1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
Bromomethane		10	1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
Carbon Disulfide			1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
Carbon Tetrachloride	5	2.7	1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
Chlorobenzene	100		1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
Chloroethane			1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
Chloroform	80		0.11	J	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
Chloromethane		3	1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
cis-1,2-Dichloroethene	70	70		NA	10	U	31	J		NA		NA		NA	3	J	2	J		NA
cis-1,3-Dichloropropene			1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
Cyclohexane				NA	10	U	200	U		NA		NA		NA	50	U	10	U		NA
Dibromochloromethane	80		1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
Dibromomethane				NA		NA		NA		NA		NA		NA		NA		NA		NA
Dichlorodifluoromethane		1050		NA	10	U	200	U		NA		NA		NA	50	U	10	U		NA
Ethyl Ether				NA		NA		NA		NA		NA		NA		NA		NA		NA

Bold/Italic - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected, NA - Not Analyzed

TABLE 3-2 (CONT.)
NORTHERN PLUME EXTRACTION WELLS
PRE- JULY 2000 VOCS AND METALS DATA
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE
PAGE 2 OF 4

Sample Station			RW-2		RW-2		RW-2		RW-2		RW-2		RW-3		RW-3		RW-3		RW-3	
Sample Number			ES-GS-RW2-030100		ESGW-RW2		ES-GW-RW2		ES-RW-2-1112		ES-RW-2-03		ES-GS-RW3-030100		ESGW-RW3		ES-GW-RW3		ES-RW-3-2930	
Date Sampled			3/1/2000		5/10/2000		6/6/2000		1/26/1999		8/13/1999		3/1/2000		5/10/2000		6/6/2000		1/26/1999	
QC Identifier			None		None		None		Field Dup. ES-RW-2-1112		None		None		None		None		None	
Criteria	MCL	MEG 1992																		
Ethylbenzene	700	700	1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
Hexachlorobutadiene		1		NA		NA		NA		NA		NA		NA		NA		NA		NA
Isopropylbenzene				NA	10	U	200	U		NA		NA		NA	50	U	10	U		NA
Methyl Acetate				NA	10	U	200	U		NA		NA		NA	50	U	10	U		NA
Methyl tert-Butyl Ether		50		NA	10	U	200	U		NA		NA		NA	50	U	10	U		NA
Methylcyclohexane				NA	10	U	200	U		NA		NA		NA	50	U	10	U		NA
Methylene Chloride	5	48	0.32	J	10	U	200	U	44	U	2	JB	56	U	3	J	10	U	220	U
n-Butylbenzene				NA		NA		NA		NA		NA		NA		NA		NA		NA
n-Propylbenzene				NA		NA		NA		NA		NA		NA		NA		NA		NA
Naphthalene		25		NA		NA		NA		NA		NA		NA		NA		NA		NA
p-Isopropyltoluene				NA		NA		NA		NA		NA		NA		NA		NA		NA
sec-Butylbenzene				NA		NA		NA		NA		NA		NA		NA		NA		NA
Styrene	100	5	1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
tert-Butylbenzene				NA		NA		NA		NA		NA		NA		NA		NA		NA
Tetrachloroethene	5	3	*11*		*43*		*3100*		*650*		*36*		*1400*		*3200*	*	*410*	*	*3300*	
Toluene	1000	1400	0.14	J	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
Total Xylenes	10000	800	1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
trans-1,2-Dichloroethene	100	70		NA	10	U	200	U		NA		NA		NA	50	U	10	U		NA
trans-1,3-Dichloropropene			1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
Trichlorobenzene, 1,3,5-				NA		NA		NA		NA		NA		NA		NA		NA		NA
Trichloroethene	5	5	0.74	J	0.4	J	200	U	44	U	5	J	4.4	J	*10*	J	5	J	*78*	J
Trichlorofluoromethane		2300		NA	10	U	200	U		NA		NA		NA	50	U	10	U		NA
Vinyl Chloride	2	0.15	1	U	10	U	200	U	44	U	10	U	56	U	50	U	10	U	220	U
TAL Metal Analysis (UG/L)			D00295		MAMS88		MAMP87		MAMA53		DAHU15		D00296		MAMS89		MAMT00		MAMA58	
Aluminum		*1430*		NA	379		536		487		723			NA	126	B	60.4	B	324	
Antimony	6			NA	2.1	U	4.4	U	5.0	U	1.4	U		NA	2.1	U	4.4	U	5.0	U
Arsenic	10			NA	2.3	U	9.7	B	3.0	U	3.0	U		NA	2.7	B	6.9	B	5.4	B
Barium	2000	1500		NA	3.3	B	10.0	B	148	B	8.0	B		NA	6.4	B	4.9	B	14.4	B
Beryllium	4			NA	0.35	B	0.38	B	1.0	U	0.70	U		NA	0.32	B	0.40	B	1.0	U
Cadmium	5	5		NA	0.20	U	0.30	U	1.0	U	0.30	U		NA	0.20	U	0.30	U	1.0	U
Calcium				NA	4650	B	23400		10800		6810			NA	29800		19700		14600	
Chromium	100	100		NA	0.40	U	1.4	B	1.0	U	6.1	B		NA	0.40	U	0.70	U	1.0	U
Cobalt				NA	1.5	B	1.3	U	3.0	U	2.4	B		NA	4.6	B	2.3	B	3.0	U
Copper	1300			NA	0.60	U	7.1	B	4.0	B	1.1	B		NA	0.60	U	9.5	B	6.3	B
Iron			2550	N	416		805		1250		1030		57800	N	895		795		6150	
Lead	15	*20*		NA	1.6	B	1.8	U	5.9		4.0			NA	1.3	U	1.8	U	1.0	U
Magnesium				NA	1360	B	6160		3840	B	2780	B		NA	4200	B	2340	B	4090	B
Manganese		200	116		167		152		125		55.0		*1260*		*1530*		*1450*		*535*	
Mercury	2	2		NA	0.10	U	0.10	U	0.10	U	0.095	UN		NA	0.10	B	0.10	U	0.10	U
Nickel		150		NA	1.5	B	2.4	B	5.1	B	13.5	B		NA	3.6	B	4.4	B	2.1	B
Potassium				NA	337	B	1290	B	885	B	491	B		NA	1710	B	978	B	1190	B
Selenium	50	10		NA	2.2	U	3.7	U	4.0	U	5.0	U		NA	2.2	U	3.7	U	4.0	U
Silver		50		NA	0.80	U	1.8	B	1.0	U	0.80	U		NA	0.80	U	1.9	B	1.0	U
Sodium				NA	3830	B	12200		12000		4550	B		NA	7460		5600		16200	
Thallium	2	*0.4*		NA	3.2	U	*9.0*	B	4.0	U	3.0	U		NA	3.2	U	*8.4*	B	4.0	U
Vanadium				NA	0.78	B	2.8	B	1.4	B	1.2	B		NA	0.81	B	1.5	B	1.0	U
Zinc				NA	1.3	B	15.3	B	67.7		4.0	U		NA	13.5	B	20.9		71.5	

Bold/Italic - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis, R - Rejected; NA - Not Analyzed

TABLE 3-2 (CONT.)
NORTHERN PLUME EXTRACTION WELLS
PRE- JULY 2000 VOCS AND METALS DATA
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Sample Station			RW-3		RW-4		RW-4		RW-4		RW-4		RW-4	
Sample Number			ES-RW-3-03		ES-GS-RW4-030100		ESGW-RW4		ES-GW-RW4		ES-RW-4-2324		ES-RW-4-03	
Date Sampled			6/15/1999		3/1/2000		5/10/2000		6/6/2000		1/27/1999		5/15/1999	
QC Identifier			Field Dup. ES-RW-3-03		None		None		None		None		None	
Criteria	MCL	MEG 1992												
Volatile Organic Analysis (UG/L)			DAHU33		D00297		ARC87		A00HW		DAHP82		DAHU35	
1,1,1,2-Tetrachloroethane		70		NA		NA		NA		NA		NA		NA
1,1,1-Trichloroethane	200	200	10	U	120	U	10	U	10	U	94	U	10	U
1,1,2,2-Tetrachloroethane			10	U	120	U	10	U	10	U	94	U	10	U
1,1,2-Trichloro-1,2,2-trifluoroethane				NA		NA	10	U	10	U		NA		NA
1,1,2-Trichloroethane	5	3	10	U	120	U	10	U	10	U	94	U	10	U
1,1-Dichloroethane		70	10	U	120	U	10	U	10	U	94	U	10	U
1,1-Dichloroethene	7	7	1	J	120	U	10	U	10	U	94	U	10	U
1,1-Dichloropropene				NA		NA		NA		NA		NA		NA
1,2,3-Trichlorobenzene				NA		NA		NA		NA		NA		NA
1,2,3-Trichloropropane		40		NA		NA		NA		NA		NA		NA
1,2,4-Trichlorobenzene	70	70		NA		NA	10	U	10	U		NA		NA
1,2,4-Trimethylbenzene				NA		NA		NA		NA		NA		NA
1,2-Dibromo-3-chloropropane	0.2	0.2		NA		NA	10	U	10	U		NA		NA
1,2-Dibromoethane				NA		NA	10	U	10	U		NA		NA
1,2-Dichlorobenzene	600			NA		NA	10	U	10	U		NA		NA
1,2-Dichloroethane	5	5	10	U	120	U	10	U	10	U	94	U	10	U
1,2-Dichloroethene (total)	70	70	40		120	U		NA		NA	20	J	35	
1,2-Dichloropropane	5	5	10	U	120	U	10	U	10	U	94	U	10	U
1,3,5-Trimethylbenzene				NA		NA		NA		NA		NA		NA
1,3-Dichlorobenzene		85		NA		NA	10	U	10	U		NA		NA
1,3-Dichloropropane				NA		NA		NA		NA		NA		NA
1,4-Dichlorobenzene	75			NA		NA	10	U	10	U		NA		NA
2,2-Dichloropropane				NA		NA		NA		NA		NA		NA
2-Butanone		170	10	U	1200	U	10	U	10	U	94	U	10	U
2-Chlorotoluene				NA		NA		NA		NA		NA		NA
2-Hexanone			10	U	1200	U	10	U	10	U	94	U	10	U
4-Chlorotoluene				NA		NA		NA		NA		NA		NA
4-Methyl-2-Pentanone			10	U	1200	U	10	U	10	U	94	U	10	U
Acetone			3	JB	1200	U	10	U	10	U	94	U	2	JB
Benzene	5	5	10	U	120	U	10	U	10	U	94	U	10	U
Bromobenzene				NA		NA		NA		NA		NA		NA
Bromochloromethane		92		NA		NA		NA		NA		NA		NA
Bromodichloromethane	80		10	U	120	U	10	U	10	U	94	U	10	U
Bromoform	80		10	U	120	U	10	U	10	U	94	U	10	U
Bromomethane		10	10	U	120	U	10	U	10	U	94	U	10	U
Carbon Disulfide			10	U	120	U	10	U	10	U	94	U	10	U
Carbon Tetrachloride	5	2.7	10	U	120	U	10	U	10	U	94	U	10	U
Chlorobenzene	100		10	U	120	U	10	U	10	U	94	U	10	U
Chloroethane			10	U	120	U	10	U	10	U	94	U	10	U
Chloroform	80		10	U	120	U	10	U	10	U	94	U	10	U
Chloromethane		3	10	U	120	U	10	U	10	U	94	U	10	U
cis-1,2-Dichloroethene	70	70		NA		NA	4	J	4	J		NA		NA
cis-1,3-Dichloropropene			10	U	120	U	10	U	10	U	94	U	10	U
Cyclohexane				NA		NA	10	U	10	U		NA		NA
Dibromochloromethane	80		10	U	120	U	10	U	10	U	94	U	10	U
Dibromomethane				NA		NA		NA		NA		NA		NA
Dichlorodifluoromethane		1050		NA		NA	10	U	10	U		NA		NA
Ethyl Ether				NA		NA		NA		NA		NA		NA

Bold/Italic - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

TABLE 3-2 (CONT.)
NORTHERN PLUME EXTRACTION WELLS
PRE- JULY 2000 VOCS AND METALS DATA
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Sample Station			RW-3		RW-4		RW-4		RW-4		RW-4		RW-4	
Sample Number			ES-RW-3-03		ES-GS-RW4-030100		ESGW-RW4		ES-GW-RW4		ES-RW-4-2324		ES-RW-4-03	
Date Sampled			8/15/1999		3/1/2000		5/10/2000		6/6/2000		1/27/1999		8/15/1999	
QC Identifier			Field Dup. ES-RW-3-03		None		None		None		None		None	
Criteria	MCL	MEG 1992												
Ethylbenzene	700	700	10	U	120	U	10	U	10	U	94	U	10	U
Hexachlorobutadiene		1		NA		NA		NA		NA		NA		NA
Isopropylbenzene				NA		NA	10	U	10	U		NA		NA
Methyl Acetate				NA		NA	10	U	10	U		NA		NA
Methyl tert-Butyl Ether		50		NA		NA	1	J	10	U		NA		NA
Methylcyclohexane				NA		NA	10	U	10	U		NA		NA
Methylene Chloride	5	48	2	JB	120	U	10	U	10	U	94	U	2	JB
n-Butylbenzene				NA		NA		NA		NA		NA		NA
n-Propylbenzene				NA		NA		NA		NA		NA		NA
Naphthalene		25		NA		NA		NA		NA		NA		NA
p-Isopropyltoluene				NA		NA		NA		NA		NA		NA
sec-Butylbenzene				NA		NA		NA		NA		NA		NA
Styrene	100	5	10	U	120	U	10	U	10	U	94	U	10	U
tert-Butylbenzene				NA		NA		NA		NA		NA		NA
Tetrachloroethene	5	*3*	***1300***	*	***2800***		***490***	*	***740***	*	***1300***		***1300***	*
Toluene	1000	1400	10	U	10	J	10	U	10	U	94	U	10	U
Total Xylenes	10000	600	10	U	120	U	10	U	10	U	94	U	10	U
trans-1,2-Dichloroethene	100	70		NA		NA	10	U	10	U		NA		NA
trans-1,3-Dichloropropene			10	U	120	U	10	U	10	U	94	U	10	U
Trichlorobenzene, 1,3,5-				NA		NA		NA		NA		NA		NA
Trichloroethane	5	*5*	***120***		***25***	J	*7*	J	*8*	J	*22*	J	*69*	
Trichlorofluoromethane		2300		NA		NA	10	U	10	U		NA		NA
Vinyl Chloride	2	0.15	10	U	120	U	10	U	10	U	94	U	10	U
TAL Metal Analysis (UG/L)			DAHU33		D00297		MAMS87		MAMS98		MAMA58		DAHU35	
Aluminum		*1430*	43.6	B		NA	43.2	B	56.9	B	30.7	B	56.7	B
Antimony	6		1.4	U		NA	2.1	U	4.4	U	5.0	U	1.5	B
Arsenic	10		3.0	U		NA	3.1	B	6.9	B	3.0	U	3.0	U
Barium	2000	1500	4.9	B		NA	3.6	B	2.3	B	3.0	B	4.2	B
Beryllium	4		0.70	U		NA	0.24	B	0.44	B	1.0	U	0.70	U
Cadmium	5	5	0.30	U		NA	0.20	U	0.30	U	1.4	B	0.30	U
Calcium			15600			NA	29300		13300		24400		18600	
Chromium	100	100	2.1	B		NA	0.40	U	0.80	B	1.0	U	4.0	B
Cobalt			2.4	B		NA	4.6	B	3.2	B	3.0	U	3.9	B
Copper	1300		0.80	U		NA	2.0	B	5.9	B	3.1	B	0.80	U
Iron			4900		9080	N	1210		1080		2610		3090	
Lead	15	*20*	7.9			NA	1.3	U	1.8	U	1.0	U	8.8	
Magnesium			3920	B		NA	5180		3010	B	4460	B	4000	B
Manganese		*200*	***468***		***1360***		***1270***		***995***		***278***		*720*	
Mercury	2	2	0.14	U		NA	0.11	B	0.10	U	0.10	U	0.14	U
Nickel		150	1.2	B		NA	4.4	B	3.5	B	2.4	B	1.8	B
Potassium			1090	B		NA	1020	B	724	B	1280	B	1250	B
Selenium	50	10	3.3	U		NA	2.2	U	3.7	U	4.0	U	3.3	U
Silver		50	0.62	B		NA	0.60	U	2.1	B	1.0	U	0.60	U
Sodium			5910			NA	6450		5260		10400		7870	
Thallium	2	*0.4*	3.0	U		NA	3.2	U	***12.4***		4.0	U	3.0	U
Vanadium			0.80	U		NA	0.65	B	2.0	B	1.0	U	0.80	U
Zinc			14.3	B		NA	9.4	B	17.4	B	10.4	B	7.9	B

Bold/Italic - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

TABLE 3-3
SOUTHERN PLUME EXTRACTION WELLS
PRE-JULY 2000 VOCS AND METALS DATA
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Sample Station			RWS-1		RWS-1		RWS-1		RWS-3		RWS-3		RWS-5		RWS-5		RWS-5		RWS-5		RWS-5		RWS-5		RWS-5	
Sample Number			ESTA-GW-RWS1-00		ES-RWS1-1929		ES-RWS1-3253		ES-RWS3-1930		ES-RWS3-3354		ESTA-GW-RWS5-00		ES-RWS5-1067		ES-RWS5-2839		ES-RWS5-0708		ES-RWS5-0709		ES-RWS5-0710		
Date Sampled			4/27/2000		6/10/1999		6/10/1999		6/11/1999		6/11/1999		4/27/2000		6/28/1999		6/29/1999		7/8/1999		7/9/1999		7/10/1999		
QC Identifier			None		None		None		None		None		None		None		None		None		Field Dup. ES-RWS5-0709		None		
Criteria	MCL	MEG 1992																								
Volatile Organic Analysis (UG/L)			D018C5		DAHP99		DAHQ00		DAHQ01		DAHQ02		D018D8		DAHQ18		DAHQ23		DAHX33		DAHX36		DAHX44		
1,1,1,2-Tetrachloroethane		70	1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
1,1,1-Trichloroethane	200	200	1	U	5	U	2	J	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
1,1,2,2-Tetrachloroethane			1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
1,1,2-Trichloro-1,2,2-trifluoroethane				NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA
1,1,2-Trichloroethane	5	3	1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
1,1-Dichloroethane		70	1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
1,1-Dichloroethene	7	7	1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
1,1-Dichloropropene			1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
1,2,3-Trichlorobenzene			1	U		NA		NA		NA		NA	0.6	J		NA		NA		NA		NA		NA		NA
1,2,3-Trichloropropane		40	1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
1,2,4-Trichlorobenzene	70	70	1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
1,2,4-Trimethylbenzene			1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
1,2-Dibromo-3-chloropropane	0.2	0.2	2	U		NA		NA		NA		NA	2	U		NA		NA		NA		NA		NA		NA
1,2-Dibromoethane			2	U		NA		NA		NA		NA	2	U		NA		NA		NA		NA		NA		NA
1,2-Dichlorobenzene	600		1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
1,2-Dichloroethane	5	5	1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
1,2-Dichloroethene (total)	70	70		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA
1,2-Dichloropropane	5	5	1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
1,3,5-Trimethylbenzene			1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
1,3-Dichlorobenzene		85	1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
1,3-Dichloropropane			1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
1,4-Dichlorobenzene	75		1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
2,2-Dichloropropane			1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
2-Butanone		170	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U
2-Chlorotoluene			1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
2-Hexanone				NA	5	U	5	U	5	U	5	U		NA	5	U	5	U	5	U	5	U	5	U	5	U
4-Chlorotoluene			1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
4-Methyl-2-Pentanone			3	U	5	U	5	U	5	U	5	U	3	U	5	U	5	U	5	U	5	U	5	U	5	U
Acetone			5	U	5	U	5	U	6		5	U	4	J	9	B	8	B	11		5	U	5	U		
Benzene	5	5	1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
Bromobenzene			1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
Bromochloromethane		92		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA
Bromodichloromethane	80		1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
Bromoform	80		1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
Bromomethane		10	2	U	5	U	5	U	5	U	5	U	2	U	5	U	5	U	5	U	5	U	5	U	5	U
Carbon Disulfide			1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
Carbon Tetrachloride	5	2.7	1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
Chlorobenzene	100		1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
Chloroethane			2	U	5	U	5	U	5	U	5	U	2	U	5	U	5	U	5	U	5	U	5	U	5	U
Chloroform	80		1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
Chloromethane		3	2	U	5	U	5	U	5	U	5	U	2	U	5	U	5	U	5	U	5	U	5	U	5	U
cis-1,2-Dichloroethene	70	70	1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
cis-1,3-Dichloropropene			1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
Cyclohexane				NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA
Dibromochloromethane	80		1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U
Dibromomethane			2	U		NA		NA		NA		NA	2	U		NA		NA		NA		NA		NA		NA
Dichlorodifluoromethane		1050	2	U		NA		NA		NA		NA	2	U		NA		NA		NA		NA		NA		NA
Ethyl Ether			1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
Ethylbenzene	700	700	1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U	5	U

Bold/Italic - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

TABLE 3-3 (cont.)
SOUTHERN PLUME EXTRACTION WELLS
PRE-JULY 2000 VOCS AND METALS DATA
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE
PAGE 2 OF 4

Sample Station			RWS-1		RWS-1		RWS-1		RWS-3		RWS-3		RWS-5		RWS-5		RWS-5		RWS-5		RWS-5		RWS-5		RWS-5	
Sample Number			ESTA-GW-RWS1-00		ES-RWS1-1929		ES-RWS1-3253		ES-RWS3-1930		ES-RWS3-3354		ESTA-GW-RWS5-00		ES-RWS5-1057		ES-RWS5-2639		ES-RWS5-0708		ES-RWS5-0709		ES-RWS5-0710			
Date Sampled			4/27/2000		6/10/1999		6/10/1999		6/11/1999		6/11/1999		4/27/2000		6/28/1999		6/28/1999		7/8/1999		7/9/1999		7/10/1999			
QC Identifier			None		None		None		None		None		None		None		None		None		Field Dup. ES-RWS5-0709		None			
Criteria	MCL	MEG 1992																								
Hexachlorobutadiene		1	1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
Isopropylbenzene			1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
Methyl Acetate				NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA
Methyl tert-Butyl Ether		50	5	U		NA		NA		NA		NA	5	U		NA		NA		NA		NA		NA		NA
Methylcyclohexane				NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA
Methylene Chloride	5	48	1	U	5	U	5	U	5	U	5	U	1	U	5	B	5	B	5	U	5	U	1	J		
n-Butylbenzene			1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
n-Propylbenzene			1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
Naphthalene		25	1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
p-Isopropyltoluene			1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
sec-Butylbenzene			1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
Styrene	100	5	1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U		
tert-Butylbenzene			1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
Tetrachloroethene	5	*3*	*5*		*12*		*6*		*82*		*68*		*180*		*460*		*400*		*420*		*260*		*290*			
Toluene	1000	1400	1	U	5	U	5	U	5	U	4	J	1	U	5	U	5	U	5	U	5	U	5	U		
Total Xylenes	10000	600	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U		
trans-1,2-Dichloroethene	100	70	1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U		
trans-1,3-Dichloropropene			1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U		
Trichlorobenzene, 1,3,5-			5	U		NA		NA		NA		NA	5	U		NA		NA		NA		NA		NA		NA
Trichloroethene	5	5	0.6	J	5	U	5	U	1	J	1	J	0.8	J	1	J	1	J	5	U	1	J	5	U		
Trichlorofluoromethane		2300	1	U		NA		NA		NA		NA	1	U		NA		NA		NA		NA		NA		NA
Vinyl Chloride	2	0.15	1	U	5	U	5	U	5	U	5	U	1	U	5	U	5	U	5	U	5	U	5	U		
TAL Metal Analysis (UG/L)				NA		NA		NA		NA		NA		NA		NA		NA		NA	DAHX36		DAHX44			
Aluminum		*1430*		NA		NA		NA		NA		NA		NA		NA		NA		NA	187	B	747			
Antimony	6			NA		NA		NA		NA		NA		NA		NA		NA		NA	2.3	B	2.0	U		
Arsenic	10			NA		NA		NA		NA		NA		NA		NA		NA		NA	4.0	U	4.0	U		
Barium	2000	1500		NA		NA		NA		NA		NA		NA		NA		NA		NA	8.0	B	7.2	B		
Beryllium	*4*			NA		NA		NA		NA		NA		NA		NA		NA		NA	0.10	U	0.10	U		
Cadmium	5	5		NA		NA		NA		NA		NA		NA		NA		NA		NA	0.60	U	1.1	B		
Calcium				NA		NA		NA		NA		NA		NA		NA		NA		NA	14300		12600			
Chromium	100	100		NA		NA		NA		NA		NA		NA		NA		NA		NA	1.8	B	3.1	B		
Cobalt				NA		NA		NA		NA		NA		NA		NA		NA		NA	1.7	B	4.4	B		
Copper	1300			NA		NA		NA		NA		NA		NA		NA		NA		NA	2.2	B	2.4	B		
Iron				NA		NA		NA		NA		NA		NA		NA		NA		NA	472		2600			
Lead	15	20		NA		NA		NA		NA		NA		NA		NA		NA		NA	13.2		*23.1*			
Magnesium				NA		NA		NA		NA		NA		NA		NA		NA		NA	5990		8940			
Manganese		*200*		NA		NA		NA		NA		NA		NA		NA		NA		NA	31.2		95.0			
Mercury	2	2		NA		NA		NA		NA		NA		NA		NA		NA		NA	0.14	U	0.12	U		
Nickel		150		NA		NA		NA		NA		NA		NA		NA		NA		NA	7.1	B	21.4	B		
Potassium				NA		NA		NA		NA		NA		NA		NA		NA		NA	1720	B	1560	B		
Selenium	50	10		NA		NA		NA		NA		NA		NA		NA		NA		NA	5.0	U	5.0	U		
Silver		50		NA		NA		NA		NA		NA		NA		NA		NA		NA	0.88	B	0.40	U		
Sodium				NA		NA		NA		NA		NA		NA		NA		NA		NA	8260		8170			
Thallium	2	*0.4*		NA		NA		NA		NA		NA		NA		NA		NA		NA	4.0	U	4.0	U		
Vanadium				NA		NA		NA		NA		NA		NA		NA		NA		NA	1.7	B	1.3	B		
Zinc				NA		NA		NA		NA		NA		NA		NA		NA		NA	9.0	U	9.0	U		

Bold/Italic - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

TABLE 3-3 (cont.)
SOUTHERN PLUME EXTRACTION WELLS
PRE-JULY 2000 VOCS AND METALS DATA
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Sample Station			RWS-5		RWS-6		RWS-6		RWS-6		RWS-7	
Sample Number			ES-RWS5-0711		ES-RWS6-1028		ES-RWS6-3339		ES-RWS6-95101		ESTA-GW-RWS7-00	
Date Sampled			7/11/1999		6/28/1999		6/28/1999		6/28/1999		4/28/2000	
QC Identifier			None		None		None		None		None	
Criteria	MCL	MEG 1992										
Volatile Organic Analytes (UG/L)			DAHX45		DAHQ21		DAHQ20		DAHQ19		D01832	
1,1,1,2-Tetrachloroethane		70		NA		NA		NA		NA	1	U
1,1,1-Trichloroethane	200	200	5	U	5	U	5	U	5	U	1	U
1,1,2,2-Tetrachloroethane			5	U	5	U	5	U	5	U	1	U
1,1,2-Trichloro-1,2,2-trifluoroethane				NA		NA		NA		NA		NA
1,1,2-Trichloroethane	5	3	5	U	5	U	5	U	5	U	1	U
1,1-Dichloroethane		70	5	U	5	U	5	U	5	U	1	U
1,1-Dichloroethene	7	7	5	U	5	U	5	U	5	U	1	U
1,1-Dichloropropene				NA		NA		NA		NA	1	U
1,2,3-Trichlorobenzene				NA		NA		NA		NA	1	U
1,2,3-Trichloropropane		40		NA		NA		NA		NA	1	U
1,2,4-Trichlorobenzene	70	70		NA		NA		NA		NA	1	U
1,2,4-Trimethylbenzene				NA		NA		NA		NA	1	U
1,2-Dibromo-3-chloropropane	0.2	0.2		NA		NA		NA		NA	2	U
1,2-Dibromoethane				NA		NA		NA		NA	2	U
1,2-Dichlorobenzene	600			NA		NA		NA		NA	1	U
1,2-Dichloroethane	5	5	5	U	5	U	5	U	5	U	1	U
1,2-Dichloroethene (total)	70	70		NA		NA		NA		NA		NA
1,2-Dichloropropane	5	5	5	U	5	U	5	U	5	U	1	U
1,3,5-Trimethylbenzene				NA		NA		NA		NA	1	U
1,3-Dichlorobenzene		85		NA		NA		NA		NA	1	U
1,3-Dichloropropane				NA		NA		NA		NA	1	U
1,4-Dichlorobenzene	75			NA		NA		NA		NA	1	U
2,2-Dichloropropane				NA		NA		NA		NA	1	U
2-Butanone		170	5	U	5	U	5	U	5	U	5	U
2-Chlorotoluene				NA		NA		NA		NA	1	U
2-Hexanone			5	U	5	U	5	U	5	U		NA
4-Chlorotoluene				NA		NA		NA		NA	1	U
4-Methyl-2-Pentanone			5	U	5	U	5	U	5	U	3	U
Acetone			5	U	9	B	10	B	10	B	19	B
Benzene	5	5	5	U	5	U	5	U	5	U	1	U
Bromobenzene				NA		NA		NA		NA	1	U
Bromochloromethane		92		NA		NA		NA		NA		NA
Bromodichloromethane	80		5	U	5	U	5	U	5	U	1	U
Bromoform	80		5	U	5	U	5	U	5	U	1	U
Bromomethane		10	5	U	5	U	5	U	5	U	2	U
Carbon Disulfide			5	U	5	U	5	U	5	U	1	U
Carbon Tetrachloride	5	2.7	5	U	5	U	5	U	5	U	1	U
Chlorobenzene	100		5	U	5	U	5	U	5	U	1	U
Chloroethane			5	U	5	U	5	U	5	U	2	U
Chloroform	80		5	U	5	U	5	U	5	U	1	U
Chloromethane		3	5	U	5	U	5	U	5	U	2	U
cis-1,2-Dichloroethene	70	70	5	U	5	U	5	U	5	U	1	U
cis-1,3-Dichloropropane			5	U	5	U	5	U	5	U	1	U
Cyclohexane				NA		NA		NA		NA		NA
Dibromochloromethane	80		5	U	5	U	5	U	5	U	1	U
Dibromomethane				NA		NA		NA		NA	2	U
Dichlorodifluoromethane		1050		NA		NA		NA		NA	2	U
Ethyl Ether				NA		NA		NA		NA	1	U
Ethylbenzene	700	700	5	U	5	U	5	U	5	U	1	U

Bold/Italic - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis, R - Rejected, NA - Not Analyzed

TABLE 3-3 (cont.)
SOUTHERN PLUME EXTRACTION WELLS
PRE-JULY 2000 VOCS AND METALS DATA
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE
PAGE 4 OF 4

Sample Station			RWS-5		RWS-6		RWS-6		RWS-6		RWS-7		
Sample Number			ES-RWS5-0711		ES-RWS6-1028		ES-RWS6-3339		ES-RWS6-95101		ESTA-GW-RWS7-00		
Date Sampled			7/11/1999		6/28/1999		6/28/1999		6/28/1999		4/28/2000		
QC Identifier			None		None		None		None		None		
Criteria	MCL	MEG 1992											
Hexachlorobutadiene		1		NA		NA		NA		NA	1	U	
Isopropylbenzene				NA		NA		NA		NA	1	U	
Methyl Acetate				NA		NA		NA		NA		NA	
Methyl tert-Butyl Ether		50		NA		NA		NA		NA	5	U	
Methylcyclohexane				NA		NA		NA		NA		NA	
Methylene Chloride	5	48	5	U	6	B	8	B	5	B	1	U	
n-Butylbenzene				NA		NA		NA		NA	1	U	
n-Propylbenzene				NA		NA		NA		NA	1	U	
Naphthalene		25		NA		NA		NA		NA	1	U	
p-Isopropyltoluene				NA		NA		NA		NA	1	U	
sec-Butylbenzene				NA		NA		NA		NA	1	U	
Styrene	100	5	5	U	5	U	5	U	5	U	1	U	
tert-Butylbenzene				NA		NA		NA		NA	1	U	
Tetrachloroethene	5	*3*	*330*		*300*		*110*		*250*		*24*		
Toluene	1000	1400	5	U	1	J	1	J	1	J	1	U	
Total Xylenes	10000	600	5	U	5	U	5	U	5	U	5	U	
trans-1,2-Dichloroethene	100	70	5	U	5	U	5	U	5	U	1	U	
trans-1,3-Dichloropropene			5	U	5	U	5	U	5	U	1	U	
Trichlorobenzene, 1,3,5-				NA		NA		NA		NA	5	U	
Trichloroethene	5	5	5	U	5	U	5	U	5	U	1	U	
Trichlorofluoromethane		2300		NA		NA		NA		NA	1	U	
Vinyl Chloride	2	0.15	5	U	5	U	5	U	5	U	1	U	
TAL Metal Analysis (UG/L)			DAHX45			NA		NA		NA		NA	
Aluminum		*1430*	233			NA		NA		NA		NA	
Antimony	6		2.0	U		NA		NA		NA		NA	
Arsenic	10		4.0	U		NA		NA		NA		NA	
Barium	2000	1500	4.2	B		NA		NA		NA		NA	
Beryllium	4		0.10	U		NA		NA		NA		NA	
Cadmium	5	5	0.67	B		NA		NA		NA		NA	
Calcium			12200			NA		NA		NA		NA	
Chromium	100	100	1.2	B		NA		NA		NA		NA	
Cobalt			0.60	U		NA		NA		NA		NA	
Copper	1300		1.0	B		NA		NA		NA		NA	
Iron			471			NA		NA		NA		NA	
Lead	15	*20*	13.5			NA		NA		NA		NA	
Magnesium			5110			NA		NA		NA		NA	
Manganese		*200*	15.9			NA		NA		NA		NA	
Mercury	2	2	0.13	U		NA		NA		NA		NA	
Nickel		150	4.6	B		NA		NA		NA		NA	
Potassium			1580	B		NA		NA		NA		NA	
Selenium	50	10	5.0	U		NA		NA		NA		NA	
Silver		50	0.66	B		NA		NA		NA		NA	
Sodium			8080			NA		NA		NA		NA	
Thallium	2	*0.4*	4.0	U		NA		NA		NA		NA	
Vanadium			0.76	B		NA		NA		NA		NA	
Zinc			9.0	U		NA		NA		NA		NA	

Bold/Italic - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

TABLE 4-1
TETRACHLOROETHENE TRENDS IN SELECTED WELLS
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

PCE in Northern Plume (ug/L)											
	Jun-99	Jan-00	Feb-00	Apr/May 00	Jun-00	Sep-00	Nov-00	Dec-00	Mar/Apr 01	Jun-01	Nov-01
Overburden Monitoring Wells											
MW-3S	98	ns	ns	3000	ns	dry	ns	dry	ns	dry	dry
MW-20S	dry	ns	ns	dry	ns	dry	ns	dry	ns	dry	dry
MW-23S	dry	ns	ns	130	ns	380	ns	16	ns	dry	dry
MW-42S	na	na	na	na	na	na	na	na	300	100	dry
MW-42SB	na	na	na	na	na	na	na	10	ns	ns	dry
MW-43S	na	na	na	na	na	na	na	na	820	ns	dry
MW-44S	na	na	na	na	ns	31	ns		360	dry	dry
MW-44SB	na	na	na	na	na	na	na	18	ns	ns	dry
MW-45S	na	na	na	na	na	na	na	na	27	dry	dry
MW-46S	na	na	na	na	na	na	na	na	90	dry	dry
Bedrock Monitoring Wells											
MW-3B	50	ns	ns	12000	ns	13	9 B	7		1600	23
MW-4B	ns	1U	ns	1U	ns	ns	ns	1U	13	8	2
MW-20B	2700	ns	ns	5 J	ns	12000	16000 B	5100	8000 B	2500	270
MW-23B	790	ns	ns	ns	ns	450	ns	830		300	240
MW-34B1	na	560	2800	660	450	1500	22000 B	2900	7400 B	1300	6600
MW-34B2	na	120	85	78	77	ns	49 B	5	1 J	6	24
MW-35B1	na	5900	7200	270	460	16000	12000 B	6800	9700	2100	9100
MW-35B2	na	7100	2600	710	ns	14000	8800 B	6300	360	ns	na
MW-36B1	na	1100	730	950	810	1300	ns	1700	810	840	230
MW-36B2	na	440	360	620	490	470	ns	360	15	46	12
MW-39B1	na	na	na	na	300	ns	ns	2000	500	160	180
MW-39B2	na	na	na	na	260	ns	ns	1600	NS	ns	na
MW-40B1	na	na	na	na	1 J	ns	ns	6	2	11	10
MW-40B2	na	na	na	na	1 J	ns	ns	17	NS	ns	na
MW-41B1	na	na	na	na	na	na	na	na	300	ns	56
MW-41B2	na	na	na	na	na	na	na	na	220	ns	11
MW-42B1	na	na	na	na	na	na	na	na	150	ns	820
MW-42B1	na	na	na	na	na	na	na	na	160	ns	82
MW-43B1	na	na	na	na	na	na	na	na	840	ns	150
MW-43B2	na	na	na	na	na	na	na	na	1200	ns	180
IN-1B (open hole)	na	na	na	na	na	1800	1800 B	5400	22	na	na
IN-2B (open hole)	na	na	na	na	na	2200	2100 B	3100	2	na	na
IN-1B1	na	na	na	na	na	na	na	na	na	3900	1400
IN-1B2	na	na	na	na	na	na	na	na	na	25	300
IN-2B1	na	na	na	na	na	na	na	na	na	1300	140
IN-2B2	na	na	na	na	na	na	na	na	na	7	100
RW-1	46	120	18	6 J	9	ns	ns	7			ns
RW-5	420	ns	330	210	ns	370	ns	2800	18	ns	430
RW7-B1	5	45	12	27	17	57	ns	170	500	220	90
RW7-B2	5	74	27	130	240	130	ns	150		tubing stuck	ns
Extraction Wells [Bedrock/Overburden]											
RW-2	36	ns	ns	43	3100	3	ns	4		64	4
RW-3	1300	ns	ns	3200	410	34	ns	120	2400	1600	110
RW-4	1300	ns	ns	490	740	ns	ns	880	1900	1700	2700
RW-8	na	na	na	na	na	na	na	na	270	83	150
RW-9	na	na	na	na	na	na	na	na	690	230	180
RW-10	na	na	na	na	na	na	na	na	610	25	56
RW-11	na	na	na	na	na	na	na	na	150	24	140

TABLE 4-1 (cont.)
TETRACHLOROETHENE TRENDS IN SELECTED WELLS
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

PCE in Southern Plume (ug/L)											
	Jun-99	Jan-00	Feb-00	Apr/May 00	Jun-00	Sep-00	Nov-00	Dec-00	Mar/Apr 01	Jun-01	Nov-01
Overburden Monitoring Wells											
MW-8S	570	ns	ns	350	ns	52	ns	78	44	34	
MW-10S	1U	ns	ns	1 U	ns	ns	ns	1 U	ns	1 U	1 U
MW-11S	1 U	ns	ns	1 U	ns	ns	ns	1 U	ns	1 U	1 U
MW-13S	140	ns	ns	6	ns	ns	ns	ns	ns	dry	dry
MW-18S	ns	ns	ns	42	ns	58	ns	67	ns	24	dry
MW-19S	dry	ns	ns	ns	ns	dry	ns	ns	ns	dry	dry
MW-25S	ns	ns	ns	9	ns	dry	ns	4	ns	2	2
MW-30S	na	na	na	93	ns	22 B	ns	14	ns	17	1
MW-31S	na	na	na	170	ns	160	ns	91	56	43	9
MW-32S	na	na	na	na	ns	ns	ns	6	ns	38	dry
MW-33S	na	na	na	na	ns	55	ns	41	ns	55	dry
IS-1S	na	na	na	na	na	94 B	ns	72	54	44	8
IS-2S	na	na	na	na	na	71 B	ns	72	ns	48	11
Bedrock Monitoring Wells											
MW-8B1	52	ns	ns	150	ns	1 U	ns	2	2	4	17
MW-8B2	200	ns	ns	140	ns	ns	ns	ns	ns	ns	ns
MW-10B	0 6 JB	ns	ns	1 U	ns	ns	ns	1 U	ns	1 U	1
MW-11B	1 U	ns	ns	2	ns	ns	ns	3	ns	1 U	3
MW-19B	3	ns	ns	3	ns	ns	ns	2	ns	1 U	1 J
MW-22B	4 JB	ns	ns	6	ns	3	ns	2	ns	1 U	4
MW-25B	0 8 JB	ns	ns	2	ns	ns	ns	2	ns	1 U	5
IS-1B	na	na	na	na	na	1 B	ns	4	37	3	2
IS-2B	na	na	na	na	na	1 B	ns	2	ns	21	19
Monitoring Wells [Bedrock/Overburden]											
RWS-2	na	na	ns	ns	ns	ns	ns	9	ns	ns	6
RWS-4	na	na	ns	190	ns	77 B	ns	93	45	ns	46
RWS-8	na	na	na	na	na	ns	ns	14	ns	ns	11
Extraction Wells [Bedrock/Overburden]											
RWS-1	na	na	ns	6	ns	ns	ns	2	ns	1 U	1 U
RWS-3	na	na	ns	ns	ns	56 B	ns	6	ns	13	6
RWS-5	na	na	ns	180	ns	14 B	ns	7	13	26	35
RWS-6	na	na	ns	120	ns	45 B	ns	38	3	6	10
RWS-7	na	na	ns	24	ns	19 B	ns	1U	ns	6	18

PCE in Non-Plume Wells (ug/L)											
MW-15S	1u	ns	ns	ns	ns	ns	ns	1U	ns	1 U	1 U
MW-15B1	10	ns	ns	1U	ns	ns	ns	5U	ns	1 U	1 U
MW-15B2	ns	ns	ns	1U	ns	ns	ns	1U	ns	1 U	1 U
MW-16S	1u	ns	ns	ns	ns	ns	ns	1U	ns	1 U	1 U
MW-16B1	1u	ns	ns	ns	ns	ns	ns	1U	ns	1 U	1 U
MW-16B2	ns	ns	ns	ns	ns	ns	ns	1U	ns	1 U	1 U
MW-26B	0.8JB	17	ns	2	ns	ns	ns	1U	ns	1 U	1 U
MW-37S	ns	ns	ns	ns	ns	ns	ns	ns	ns	1 U	1 U
MW-37SB	ns	ns	ns	ns	ns	ns	ns	1U	ns	1 U	1 U
MW-37B1	ns	ns	0.64J	1U	2J	ns	ns	12	ns	2	1 J
MW-37B2	ns	ns	1.9U	1 1	10U	ns	ns	1U	ns	1 U	1 J
MW-38B	ns	ns	ns	1U	ns	ns	ns	1U	ns	1 U	1 J

Notes:

Phase 1 First $NaMnO_4$ dose applied during July 2000 into MW-34B1. MW-35B1, IN-1B, and IN-2B
Groundwater with NaMnO4 was recirculated in aquifer during August 2000.
Second $NaMnO_4$ dose applied Sept 22, 2000 into MW-20B, MW-34B1, MW-35B2, IN-1B, and IN-2B after analytical results were received
Third $NaMnO_4$ dose applied during Jan 2001

Phase 2 $NaMnO_4$ dose applied during late April-May 2001 into select monitoring wells and DP wells

Abbr:
na - not applicable, well not constructed
ns - not sampled
B - laboratory blank contamination was present, but only low conc
J - quantitation approximate
U - detection limit

TABLE 4-2
NORTHERN PLUME EXTRACTION WELLS
NOVEMBER 2001 VOCS AND METALS DATA
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Sample Number			ESRA-GW-RW2-110201		ESRA-GW-RW3-110201		ESRA-GW-RW4-110201		ESRA-GW-DUP01-110201	
Sample Location			RW-2		RW-3		RW-4		RW-4	
Date Sampled			11/2/2001		11/2/2001		11/2/2001		11/2/2001	
filtered			Unfiltered		Unfiltered		Unfiltered		Unfiltered	
QC Identifier	MCL	MEG_1992	None		None		Field Dup. ESRA-GW-RW4-110201		Field Dup ESRA-GW-RW4-110201	
Volatile Organic Analysis (UG/L)										
1,1,1,2-Tetrachloroethane		70	1	U	1	U	10	U	20	U
1,1,1-Trichloroethane	200	200	1	U	1	U	10	U	20	U
1,1,2,2-Tetrachloroethane			1	U	1	U	10	U	20	U
1,1,2-Trichloroethane	5	3	1	U	1	U	10	U	20	U
1,1-Dichloroethane		70	1	U	1	U	10	U	20	U
1,1-Dichloroethene	7	7	1	U	1	U	10	U	20	U
1,1-Dichloropropene			1	U	1	U	10	U	20	U
1,2,3-Trichlorobenzene			1	U	1	U	10	U	20	U
1,2,3-Trichloropropane		40	1	U	1	U	10	U	20	U
1,2,4-Trichlorobenzene	70	70	1	U	1	U	10	U	20	U
1,2,4-Trimethylbenzene			1	U	1	U	10	U	20	U
1,2-Dibromo-3-chloropropane	0.2	0.2	1	U	1	U	10	U	20	U
1,2-Dibromoethane			1	U	1	U	10	U	20	U
1,2-Dichlorobenzene	600		1	U	1	U	10	U	20	U
1,2-Dichloroethane	5	5	1	U	1	U	10	U	20	U
1,2-Dichloropropane	5	5	1	U	1	U	10	U	20	U
1,3,5-Trimethylbenzene			1	U	1	U	10	U	20	U
1,3-Dichlorobenzene		85	1	U	1	U	10	U	20	U
1,3-Dichloropropane			1	U	1	U	10	U	20	U
1,4-Dichlorobenzene	75		1	U	1	U	10	U	20	U
2,2-Dichloropropane				NA		NA		NA		NA
2-Butanone		170	5	U	5	U	50	U	100	U
2-Chlorotoluene			1	U	1	U	10	U	20	U
2-Hexanone			5	U	5	U	50	U	100	U
4-Chlorotoluene			1	U	1	U	10	U	20	U
4-Methyl-2-Pentanone			5	U	5	U	50	U	100	U
Acetone			5	U	5	U	50	U	100	U
Benzene	5	5	1	U	1	U	10	U	20	U
Bromobenzene			1	U	1	U	10	U	20	U
Bromochloromethane		92	1	U	1	U	10	U	20	U
Bromodichloromethane	80		1	U	1	U	10	U	20	U
Bromoform	80		1	U	1	U	10	U	20	U
Bromomethane		10	1	U	1	U	10	U	20	U

TABLE 4-2 (CONT.)
NORTHERN PLUME EXTRACTION WELLS
NOVEMBER 2001 VOCS AND METALS DATA
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Sample Number			ESRA-GW-RW2-110201		ESRA-GW-RW3-110201		ESRA-GW-RW4-110201		ESRA-GW-DUP01-110201	
Sample Location			RW-2		RW-3		RW-4		RW-4	
Date Sampled			11/2/2001		11/2/2001		11/2/2001		11/2/2001	
filtered			Unfiltered		Unfiltered		Unfiltered		Unfiltered	
QC Identifier	MCL	MEG_1992	None		None		Field Dup. ESRA-GW-RW4-110201		Field Dup. ESRA-GW-RW4-110201	
Carbon Disulfide			1	U	1	U	10	U	20	U
Carbon Tetrachloride	5	2.7	1	U	1	U	10	U	20	U
Chlorobenzene	100		1	U	1	U	10	U	20	U
Chloroethane			1	U	1	U	10	U	20	U
Chloroform	80		1	U	1	U	10	U	20	U
Chloromethane		3	1	U	1	U	10	U	20	U
cis-1,2-Dichloroethene	**70**	70	1	U	2		***88***		***330***	
cis-1,3-Dichloropropene			1	U	1	U	10	U	20	U
Dibromochloromethane	80		1	U	1	U	10	U	20	U
Dibromomethane			1	U	1	U	10	U	20	U
Dichlorodifluoromethane		1050	1	U	1	U	10	U	20	U
Ethylbenzene	700	700	1	U	1	U	10	U	20	U
Hexachlorobutadiene		1	1	U	1	U	10	U	20	U
Iodomethane			1	U	1	U	10	U	20	U
Isopropylbenzene			1	U	1	U	10	U	20	U
m&p-Xylene				NA		NA		NA		NA
Methyl tert-Butyl Ether		50	1	U	1	U	10	U	20	U
Methylene Chloride	5	48	1	U	1	U	10	U	20	U
n-Butylbenzene			1	U	1	U	10	U	20	U
n-Propylbenzene			1	U	1	U	10	U	20	U
Naphthalene		25	1	U	1	U	10	U	20	U
o-Xylene			1	U	1	U	10	U	20	U
p-Isopropyltoluene			1	U	1	U	10	U	20	U
sec-Butylbenzene			1	U	1	U	10	U	20	U
Styrene	100	5	1	U	1	U	10	U	20	U
tert-Butylbenzene			1	U	1	U	10	U	20	U
Tetrachloroethene	**5**	3	***4***		***110***		***1500***		***2700***	
Toluene	1000	1400	1	U	1	U	10	U	20	U
Total Xylenes	10000	600	1	U	1	U	10	U	20	U
trans-1,2-Dichloroethene	100	70	1	U	1	U	10	U	20	U
trans-1,3-Dichloropropene			1	U	1	U	10	U	20	U
Trichloroethene	**5**	5	1	U	4		***49***		***99***	
Trichlorofluoromethane		2300	1	U	1	U	10	U	20	U
Vinyl Acetate			1	U	1	U	10	U	20	U
Vinyl Chloride	2	0.15	1	U	1	U	10	U	20	U

Bold/Italic - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

TABLE 4-2 (CONT.)
NORTHERN PLUME EXTRACTION WELLS
NOVEMBER 2001 VOCS AND METALS DATA
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Sample Number			ESRA-GW-RW2-110201		ESRA-GW-RW3-110201		ESRA-GW-RW4-110201		ESRA-GW-DUP01-110201	
Sample Location			RW-2		RW-3		RW-4		RW-4	
Date Sampled			11/2/2001		11/2/2001		11/2/2001		11/2/2001	
filtered			Unfiltered		Unfiltered		Unfiltered		Unfiltered	
QC Identifier	MCL	MEG_1992	None		None		Field Dup. ESRA-GW-RW4-110201		Field Dup. ESRA-GW-RW4-110201	
TAL Metal Analysis (UG/L)										
Aluminum		*1430*	*11500*		216		*4520*		*1670*	
Antimony	**6**		3.7	U	3.7	U	**13.1**	B	3.7	U
Arsenic	**10**		3.0	U	7.3	B	**1030**		**297**	
Barium	2000	1500	114	B	5.0	B	765		289	
Beryllium	**4**		0.58	B	0.40	U	3.8	B	1.7	B
Cadmium	**5**	*5*	0.40	U	0.40	U	**10.6**		2.4	B
Calcium			15700		11600		79500		40900	
Chromium	**100**	*100*	22.2		1.4	B	73.9		23.4	
Cobalt			29.5	B	4.2	B	252		154	
Copper	1300		15.1	B	4.1	B	130		44.6	
Iron			19700		4550		736000		246000	
Lead	**15**	*20*	9.9		2.2	U	***30.0***		13.3	
Magnesium			22500		2930	B	9060		5750	
Manganese		*200*	*963*		*1230*		*37900*		*23900*	
Mercury	2	2	0.10	U	0.10	U	0.10	U	0.10	U
Nickel		150	68.8		3.3	B	78.7		36.0	B
Potassium			2440	B	1160	B	4720	B	2680	B
Selenium	50	*10*	4.8	U	4.8	U	*26.8*		*12.4*	
Silver		50	1.0	U	1.0	U	1.1	B	1.0	U
Sodium			6620		7450		25800		18800	
Thallium	**2**	*0.4*	5.2	U	5.2	U	***48.9***		***26.4***	
Vanadium			16.6	B	2.1	B	109		32.0	B
Zinc			43.2		309		400		125	

Bold/Italic - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

TABLE 4-3
SOUTHERN PLUME EXTRACTION WELLS
NOVEMBER 2001 VOC AND METALS DATA
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Sample Number			ESRA-GW-RWS1-110201		ESRA-GW-RWS3-110201		ESRA-GW-DUP02-110201		ESRA-GW-RWS5-110201		ESRA-GW-RWS6-110201		ESRA-GW-RWS7-110201	
Sample Location			RWS-1		RWS-3		RWS-3		RWS-5		RWS-6		RWS-7	
Date Sampled			11/2/2001		11/2/2001		11/2/2001		11/2/2001		11/2/2001		11/2/2001	
filtered			Unfiltered		Unfiltered		Unfiltered		Unfiltered		Unfiltered		Unfiltered	
QC Identifier	MCL	MEG_1992	None		Field Dup. ESRA-GW-RWS3-110201		Field Dup. ESRA-GW-RWS3-110201		None		None		None	
Volatile Organic Analysis (UG/L)														
1,1,1,2-Tetrachloroethane		70	1	U	1	U	1	U	1	U	1	U	1	U
1,1,1-Trichloroethane	200	200	1		1	U	1	U	1	U	1	U	1	U
1,1,2,2-Tetrachloroethane			1	U	1	U	1	U	1	U	1	U	1	U
1,1,2-Trichloroethane	5	3	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethane		70	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloroethene	7	7	1	U	1	U	1	U	1	U	1	U	1	U
1,1-Dichloropropene			1	U	1	U	1	U	1	U	1	U	1	U
1,2,3-Trichlorobenzene			1	U	1	U	1	U	1	U	1	U	1	U
1,2,3-Trichloropropane		40	1	U	1	U	1	U	1	U	1	U	1	U
1,2,4-Trichlorobenzene	70	70	1	U	1	U	1	U	1	U	1	U	1	U
1,2,4-Trimethylbenzene			1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dibromo-3-chloropropane	0.2	0.2	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dibromoethane			1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichlorobenzene	600		1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichloroethane	5	5	1	U	1	U	1	U	1	U	1	U	1	U
1,2-Dichloropropane	5	5	1	U	1	U	1	U	1	U	1	U	1	U
1,3,5-Trimethylbenzene			1	U	1	U	1	U	1	U	1	U	1	U
1,3-Dichlorobenzene		85	1	U	1	U	1	U	1	U	1	U	1	U
1,3-Dichloropropane			1	U	1	U	1	U	1	U	1	U	1	U
1,4-Dichlorobenzene	75		1	U	1	U	1	U	1	U	1	U	1	U
2,2-Dichloropropane				NA		NA		NA		NA		NA		NA
2-Butanone		170	5	U	5	U	5	U	5	U	5	U	5	U
2-Chlorotoluene			1	U	1	U	1	U	1	U	1	U	1	U
2-Hexanone			5	U	5	U	5	U	5	U	5	U	5	U
4-Chlorotoluene			1	U	1	U	1	U	1	U	1	U	1	U
4-Methyl-2-Pentanone			5	U	5	U	5	U	5	U	5	U	5	U
Acetone			5	U	5	U	5	U	5	U	5	U	5	U
Benzene	5	5	1	U	1	U	1	U	1	U	1	U	1	U
Bromobenzene			1	U	1	U	1	U	1	U	1	U	1	U
Bromochloromethane		92	1	U	1	U	1	U	1	U	1	U	1	U
Bromodichloromethane	80		1	U	1	U	1	U	1	U	1	U	1	U
Bromoform	80		1	U	1	U	1	U	1	U	1	U	1	U
Bromomethane		10	1	U	1	U	1	U	1	U	1	U	1	U
Carbon Disulfide			1	U	1	U	1	U	1	U	1	U	1	U
Carbon Tetrachloride	5	2.7	1	U	1	U	1	U	1	U	1	U	1	U
Chlorobenzene	100		1	U	1	U	1	U	1	U	1	U	1	U
Chloroethane			1	U	1	U	1	U	1	U	1	U	1	U
Chloroform	80		1	U	1	U	1	U	1	U	1	U	1	U
Chloromethane		3	1	U	1	U	1	U	1	U	1	U	1	U
cis-1,2-Dichloroethene	70	70	1	U	1	U	1	U	1	U	1	U	1	U
cis-1,3-Dichloropropene			1	U	1	U	1	U	1	U	1	U	1	U
Dibromochloromethane	80		1	U	1	U	1	U	1	U	1	U	1	U
Dibromomethane			1	U	1	U	1	U	1	U	1	U	1	U
Dichlorodifluoromethane		1050	1	U	1	U	1	U	1	U	1	U	1	U
Ethylbenzene	700	700	1	U	1	U	1	U	1	U	1	U	1	U

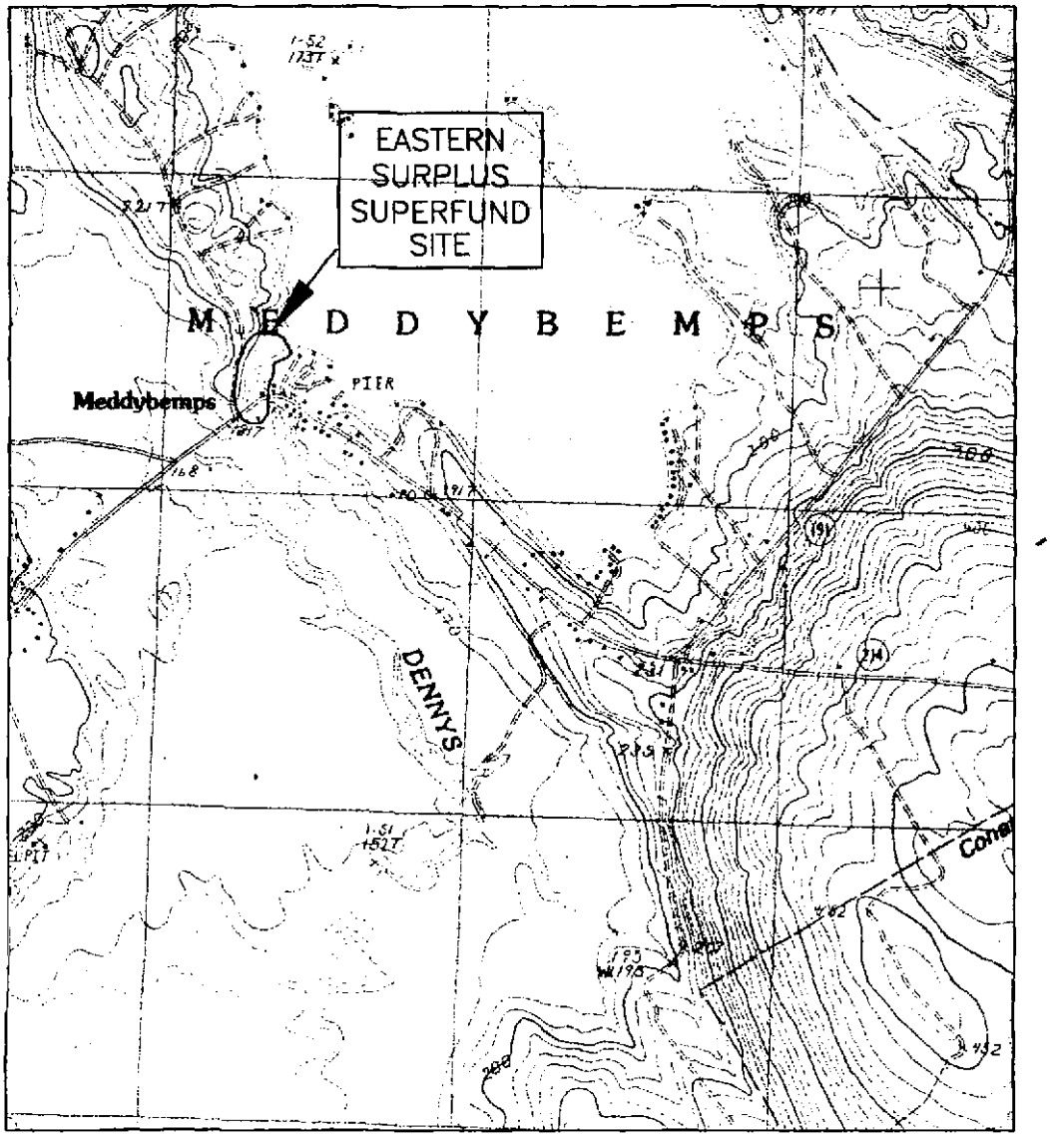
Bold/Italic - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate, J - Quantitation approximate;
* - From dilution analysis; R - Rejected, NA - Not Analyzed

TABLE 4-3 (CONT.)
SOUTHERN PLUME EXTRACTION WELLS
NOVEMBER 2001 VOC AND METALS DATA
DRAFT IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

Sample Number			ESRA-GW-RWS1-110201		ESRA-GW-RWS3-110201		ESRA-GW-DUP02-110201		ESRA-GW-RWS5-110201		ESRA-GW-RWS6-110201		ESRA-GW-RWS7-110201	
Sample Location			RWS-1		RWS-3		RWS-3		RWS-5		RWS-6		RWS-7	
Date Sampled			11/2/2001		11/2/2001		11/2/2001		11/2/2001		11/2/2001		11/2/2001	
Filtered			Unfiltered		Unfiltered		Unfiltered		Unfiltered		Unfiltered		Unfiltered	
QC Identifier	MCL	MEG_1992	None		Field Dup. ESRA-GW-RWS3-110201		Field Dup. ESRA-GW-RWS3-110201		None		None		None	
Hexachlorobutadiene		1	1	U	1	U	1	U	1	U	1	U	1	U
Iodomethane			1	U	1	U	1	U	1	U	1	U	1	U
Isopropylbenzene			1	U	1	U	1	U	1	U	1	U	1	U
m&p-Xylene				NA		NA		NA		NA		NA		NA
Methyl tert-Butyl Ether		50	1	U	1	U	1	U	1	U	1	U	1	U
Methylene Chloride	5	48	1	U	1	U	1	U	1	U	1	U	1	U
n-Butylbenzene			1	U	1	U	1	U	1	U	1	U	1	U
n-Propylbenzene			1	U	1	U	1	U	1	U	1	U	1	U
Naphthalene		25	1	U	1	U	1	U	1	U	1	U	1	U
o-Xylene			1	U	1	U	1	U	1	U	1	U	1	U
p-Isopropyltoluene			1	U	1	U	1	U	1	U	1	U	1	U
sec-Butylbenzene			1	U	1	U	1	U	1	U	1	U	1	U
Styrene	100	5	1	U	1	U	1	U	1	U	1	U	1	U
tert-Butylbenzene			1	U	1	U	1	U	1	U	1	U	1	U
Tetrachloroethene	5	3	1	U	*6*		*4*		*35*		*10*		*18*	
Toluene	1000	1400	1	U	1	U	1	U	1	U	1	U	1	U
Total Xylenes	10000	600	1	U	1	U	1	U	1	U	1	U	1	U
trans-1,2-Dichloroethene	100	70	1	U	1	U	1	U	1	U	1	U	1	U
trans-1,3-Dichloropropene			1	U	1	U	1	U	1	U	1	U	1	U
Trichloroethene	5	5	1	U	1	U	1	U	1	U	1	U	1	U
Trichlorofluoromethane		2300	1	U	1	U	1	U	1	U	1	U	1	U
Vinyl Acetate			1	U	1	U	1	U	1	U	1	U	1	U
Vinyl Chloride	2	0.15	1	U	1	U	1	U	1	U	1	U	1	U
TAL Metal Analysis (UG/L)														
Aluminum		*1430*	*3910*		254		269		*2190*		*5690*		878	
Antimony	6		3.7	U	3.7	U	3.7	U	3.7	U	3.7	U	3.7	U
Arsenic	10		4.0	B	3.0	U	3.0	U	3.1	B	5.3	B	3.0	B
Barium	2000	1500	41.3	B	5.2	B	5.0	B	17.1	B	62.3	B	26.9	B
Beryllium	4		0.58	B	0.40	U	0.40	U	0.40	U	0.90	B	0.40	U
Cadmium	5	5	0.40	U	0.40	U	0.40	U	0.40	U	0.40	U	0.40	U
Calcium			17300		13100		13500		22100		10300		33700	
Chromium	100	100	6.7	B	1.9	B	1.7	B	5.8	B	7.6	B	1.8	B
Cobalt			13.6	B	1.0	U	1.0	U	5.2	B	6.9	B	2.5	B
Copper	1300		16.8	B	2.0	U	2.0	U	6.8	B	15.5	B	3.6	B
Iron			4910		389		467		3920		6040		1590	
Lead	15	20	*17.2*		6.0		2.8	B	6.3		*19.9*		3.0	
Magnesium			6100		6870		7060		11600		4410	B	11000	
Manganese		*200*	*736*		26.1		29.6		181		*623*		105	
Mercury	2	2	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U	0.10	U
Nickel		150	18.2	B	5.6	B	5.4	B	12.1	B	12.9	B	16.3	B
Potassium			1730	B	2030	B	2220	B	2200	B	2600	B	2910	B
Selenium	50	10	4.8	U	4.8	U	4.8	U	4.8	U	4.8	U	4.8	U
Silver		50	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Sodium			7480		11300		11700		12300		41100		18400	
Thallium	2	*0.4*	5.2	U	5.2	U	5.2	U	5.2	U	5.2	U	5.2	U
Vanadium			7.7	B	0.99	B	0.90	U	5.0	B	10.4	B	1.5	B
Zinc			82.8		1.1	U	1.1	U	12.3	B	34.1		3.2	B

Bold/Italic - Criteria Exceeded; U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

FIGURES



BASEMAP: U.S.G.S. QUADRANGLE MAP: MEDDYBEMPS LAKE EAST, MAINE, PROVISIONAL EDITION, 1987

½ 0 ½ 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

QUADRANGLE LOCATION

SITE LOCATION MAP	FIGURE 1-1
EASTERN SURPLUS COMPANY SITE	
MEDDYBEMPS, MAINE	

DRAWN BY:	J. PICCUITO	REV.:	0
CHECKED BY:	C. RACE	DATE:	OCTOBER 2001
SCALE:	AS SHOWN	ACAD NAME:	\4112\0640\FIG1_1.DWG

TETRA TECH NUS, INC.
55 Jonspin Road Wilmington, MA 01887
(978)658-7899

N

Meddybemps Lake

To Lake Meddybemps

MW-14B

Gate

MW-6S

MW-1B

IW-2B

IW-3B

MW-24B

MW-27B

Remnant Rock Pile

MW-28B

IW-4B

IW-1B

MW-34B

RW-1

MW-29B

MW-35B

MW-20S

IN-1B

MW-3S

RW-2

MW-3B

MW-5S

MW-20B

MW-42SB

MW-44SB

IN-2B

RW-3

ORCHARD WELL

Wood Frame Shed

ORCHARD RESIDENCE

ROAD

MW-23M

RW-4

MW-41B

MW-23S

MW-23B

RW-8

RW-5

Concrete Fish Way

Flow

MW-43S

MW-43B

RW-9

MW-44S

MW-42S

Sluice Gate

MW-36B

GRAVEL

MW-42B

MW-39B

Wood Frame 1-Car Garage

RW-10

RW-7

RW-11

MW-45S

MW-40B

MW-46S

MW-4B

MW-4S

MW-38(B)

Approx. Top of Bank

EXISTING

Infiltration Gallery

IG-ID

IG-IS

Recharge Gallery

IG-2D

IG-2S

Gate

Gallery Manhole

MW-7S

MW-7B

MW-12S

MW-12B

Road (So Called)

Stone

Dennys River (Mill Pond)

MW-37B

MW-37SB

MW-16B

MW-16S

Private Drive (Campbell Road - So Called)

MW-15B

MW-15S

1 Story Wood Frame Gar.

MW-19B

MW-19S

SMITH RESIDENCE

1 1/2 Story Wood Frame Bldg. (Abandoned Generator)

T.V. Antenna

SMITH WELL

Light Pole

RWS-8

MW-25S

MW-25B

MW-13S

MW-47S

RWS-7

MH

Treatment Building

MW-18S

Guardrail (Typ.)

MW-48S

RWS-6

IS-2S

IS-1S

MW-8S

MW-8B

IS-1B

MW-49S

RWS-5

MW-32S

MW-33S

MW-31S

MW-26B

Office

Old Stone Foundation (4' Deep)

Gravel Shoulder

Dennys River

IS-2B

RWS-4

MW-50S

RWS-3

MW-30S

RWS-2

Barn

To Route 214

MW-9S

MW-22B

MW-10S

MW-10B

Route 191

Wood Frame Barn

Top of Bank

Vanwart Residence

Church

VAN WART WELL

RWS-1

Trailer

To Machias, ME

MW-11B

MW-11S

Legend

- CHAIN LINK FENCE
- EDGE OF GRAVEL
- EDGE OF PAVEMENT
- EDGE OF WATER
- SITE BOUNDARY
- MONITORING WELL–BEDROCK
- MONITORING WELL–OVERBURDEN
- RECOVERY WELL
- RESIDENTIAL WELL
- MONITORING WELL – OVERBURDEN & BEDROCK
- UTILITY POLE

NOTES:

1. ELEVATIONS ARE BASED ON U.S.G.S. (NGVD 1929) MEAN SEA LEVEL.
2. BEARINGS ARE BASED ON MAINE STATE GRID COORDINATE SYSTEM (EAST ZONE) "NAD 83". DISTANCES SHOWN ARE GROUND DISTANCES AND ARE NOT REDUCED BY GRID AND ELEVATION FACTORS. CONTROL STATIONS USED: GREEN.....N = 499787.956 E = 1270274.069 ALEX.....N = 502946.205 E = 1254863.930
3. WELLS MW–47S TO MW–50S LOCATIONS APPROXIMATE, ALL OTHER WELL LOCATIONS SURVEYED.
4. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
5. PLAN NOT TO BE USED FOR DESIGN.

GRAPHIC SCALE

40' 0' 40' 80'

DRAWN BY:	D.W. MACDOUGALL
PREPARED BY:	C. RACE
CHECKED BY:	C. RACE
PROJECT MANAGER:	L. CHU
PROGRAM MANAGER:	G. GARDNER

TITLE: SITE PLAN

EASTERN SURPLUS CO. SITE – MEDDYBEMPS, MAINE

SOURCE: TOPOGRAPHIC/INSTRUMENT SURVEY PERFORMED BY OEST ASSOC. INC. DATED, OCTOBER 1996; UPDATED: JAN. 2000, APR. 2001

SCALE:	DATE:	PROJ. NO:
AS SHOWN	JANUARY 7, 2003	N4112
DRAWING NO: FIGURE 1–2	ACFILE NAME: DWG\4112\0760\FIG_1–2.DWG	REV: 0

TETRA TECH NUS, INC.

55 JONSPIN ROAD
WILMINGTON, MASSACHUSETTS 01887
(978)658–7899

NOTES:

1. ELEVATIONS ARE BASED ON U.S.G.S. (NGVD 1929) MEAN SEA LEVEL.
2. BEARINGS ARE BASED ON MAINE STATE GRID COORDINATE SYSTEM (EAST ZONE) "NAD 83". DISTANCES SHOWN ARE GROUND DISTANCES AND ARE NOT REDUCED BY GRID AND ELEVATION FACTORS. CONTROL STATIONS USED: GREEN.....N = 499787.956 E = 1270274.069 ALEX.....N = 502946.205 E = 1254863.930
3. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.

REV	DATE	DESCRIPTION	DR BY	APP BY

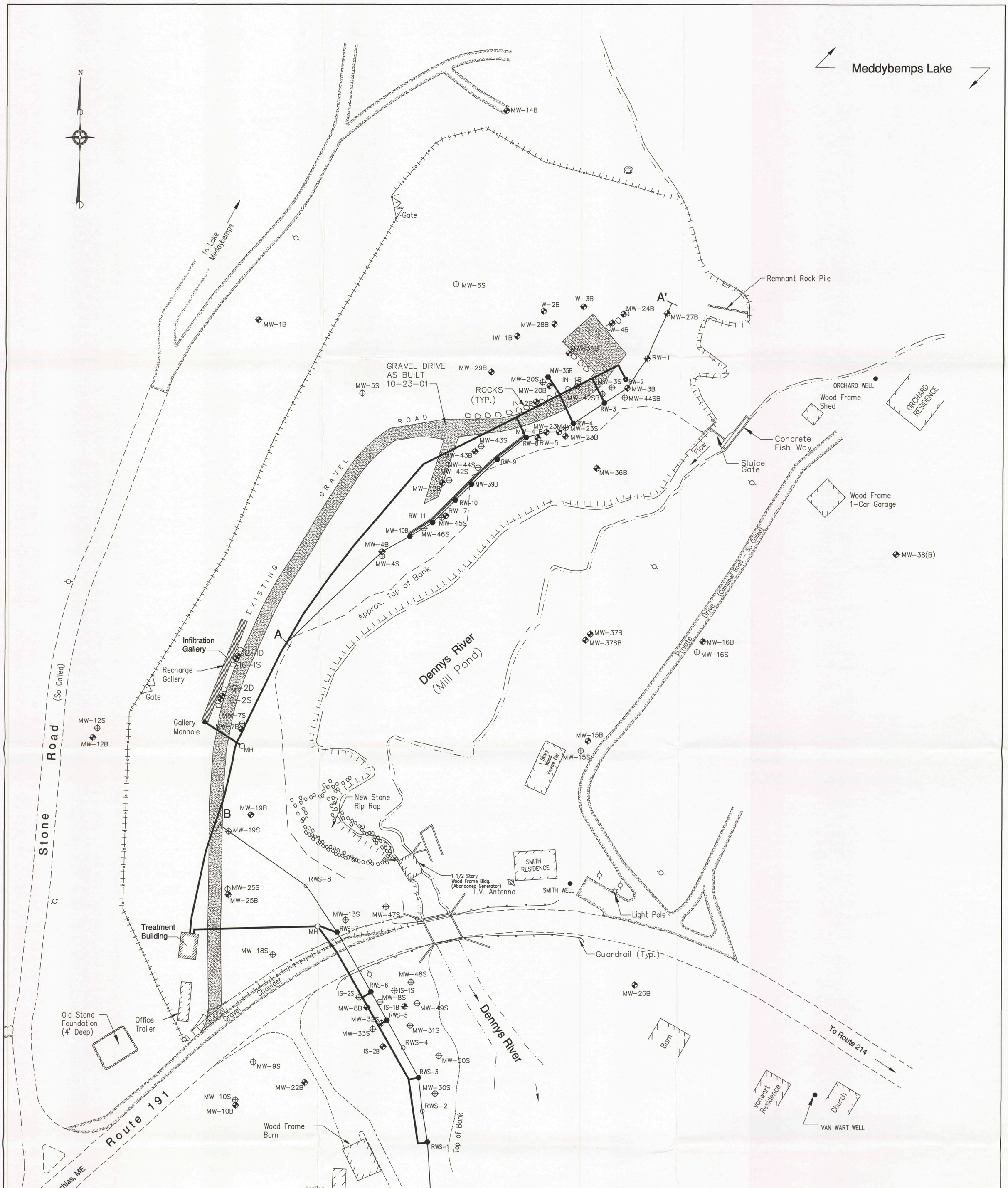
DRAWN BY: R.G. DEWSNAP
PREPARED BY: C. RACE
CHECKED BY: L. CHU
PROJECT MANAGER: L. CHU
PROGRAM MANAGER: G. GARDNER

TITLE: WELL LOCATIONS
EASTERN SURPLUS CO. SITE - MEDDYBEMPS, MAINE

SOURCE: TOPOGRAPHIC/INSTRUMENT SURVEY PERFORMED BY OEST ASSOC. INC. DATED, OCTOBER 1996; UPDATED: JAN. 2000, APR. 2001

SCALE:	DATE:	PROJ. NO:
AS SHOWN	JANUARY 7, 2003	N4112
DRAWING NO: FIGURE 2-1	ACFILE NAME: DWG\4112\0760\FIG_2-1.DWG	REV: 0

TETRA TECH NUS, INC.
55 JONSPIN ROAD
WILMINGTON, MASSACHUSETTS 01887
(978)658-7899



Legend

- CHAIN LINK FENCE
- EDGE OF GRAVEL
- EDGE OF PAVEMENT
- EDGE OF WATER
- SITE BOUNDARY
- MONITORING WELL–BEDROCK
- MONITORING WELL–OVERBURDEN
- RECOVERY WELL
- RESIDENTIAL WELL
- MONITORING WELL – OVERBURDEN & BEDROCK
- UTILITY POLE

NOTES:

1. ELEVATIONS ARE BASED ON U.S.G.S. (NGVD 1929) MEAN SEA LEVEL.
2. BEARINGS ARE BASED ON MAINE STATE GRID COORDINATE SYSTEM (EAST ZONE) "NAD 83". DISTANCES SHOWN ARE GROUND DISTANCES AND ARE NOT REDUCED BY GRID AND ELEVATION FACTORS. CONTROL STATIONS USED: GREEN.....N = 499787.956 E = 1270274.069 ALEX.....N = 502946.205 E = 1254863.930
3. WELLS MW–47S TO MW–50S LOCATIONS APPROXIMATE, ALL OTHER WELL LOCATIONS SURVEYED.
4. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
5. PLAN NOT TO BE USED FOR DESIGN.

GRAPHIC SCALE
40' 0' 40' 80'

DRAWN BY: J. PICCUITO
PREPARED BY: C. RACE
CHECKED BY: C. RACE
PROJECT MANAGER: L. CHU
PROGRAM MANAGER: G. GARDNER

TITLE: WELL LOCATIONS AND CROSS SECTION LINES
EASTERN SURPLUS CO. SITE – MEDDYBEMPS, MAINE

SOURCE: TOPOGRAPHIC/INSTRUMENT SURVEY PERFORMED BY OEST ASSOC. INC. DATED, OCTOBER 1996; UPDATED: JAN. 2000, APR. 2001

SCALE:	DATE:	PROJ. NO:
AS SHOWN	JANUARY 2003	N4112
DRAWING NO: FIGURE 3–1	ACFILE NAME: DWG\4112\0760\FIG_3–1.DWG	REV: 0

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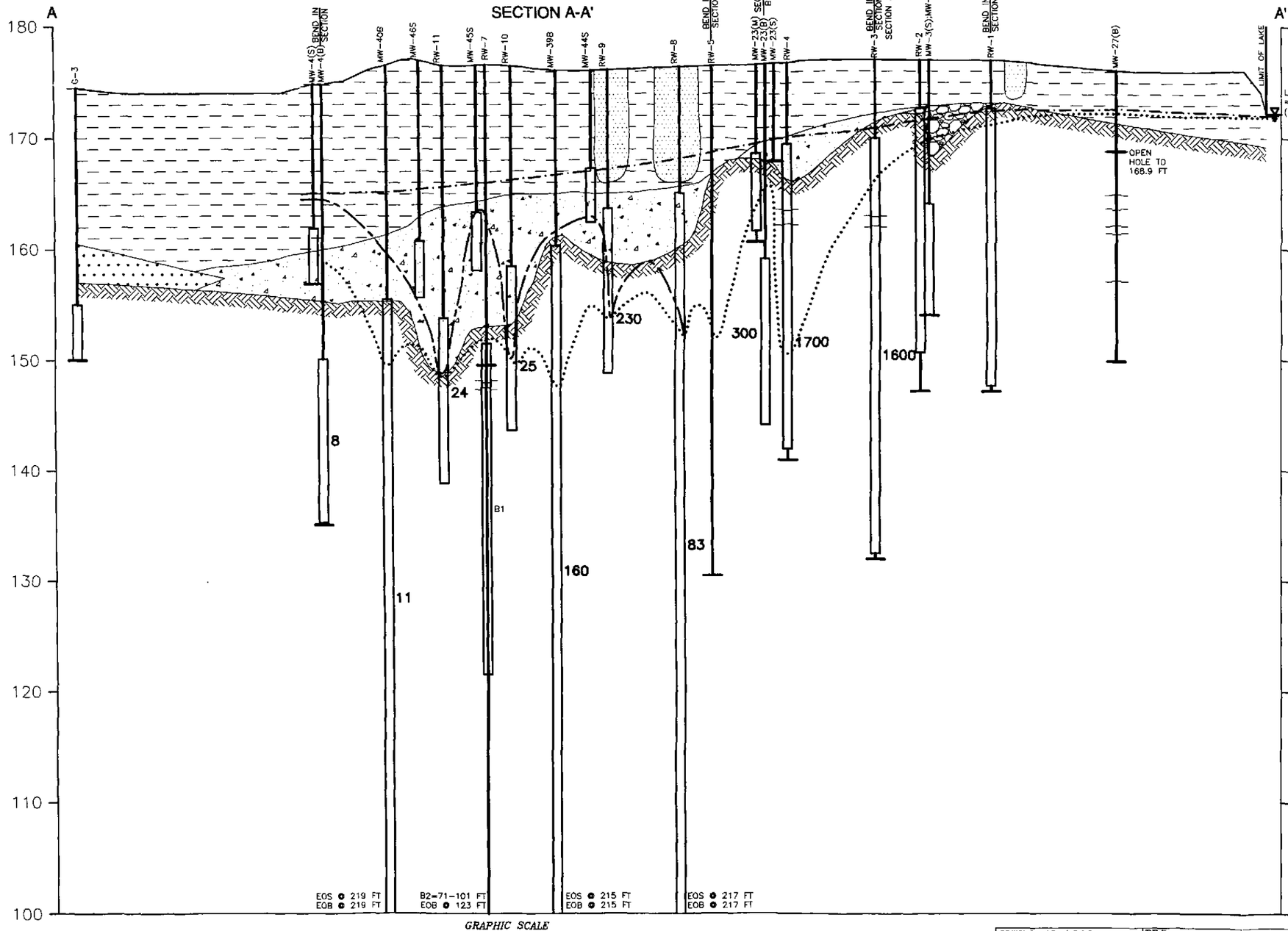
(978)658–7899

SECTION A-A'



GRAPHIC SCALE

HORIZONTAL SCALE: 50' 0' 50' 100'

VERTICAL SCALE: 10' 0' 10' 20'

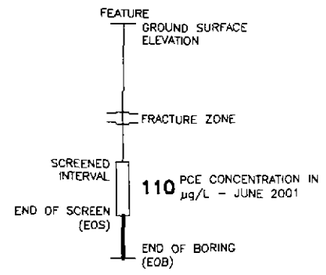
NOTES:

1. THE DEPTH, THICKNESS, AND CONTINUITY OF THE SUBSURFACE MATERIALS INDICATED ON THE PROFILES WERE GENERALIZED FROM, AND INTERPOLATED BETWEEN SUBSURFACE BORINGS FROM DATA REPORTED ON BORING LOGS. INFORMATION REGARDING SUBSURFACE CONDITIONS AND WATER LEVELS EXISTS ONLY AT THE SPECIFIC LOCATION OF EACH BORING AND AT THE TIME THE BORING WAS SAMPLED. THE LINES DEPICTING THE DISTRIBUTION OF THE SUBSURFACE MATERIALS REPRESENT AN ESTIMATED, APPROXIMATE BOUNDARY, AND THE ACTUAL BOUNDARIES MAY DIFFER FROM THOSE SHOWN. THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN SOIL CONDITIONS AND/OR WATER LEVELS FROM THOSE SHOWN.
2. PLAN NOT TO BE USED FOR DESIGN.
3. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.

LEGEND:

- SANDS/GRAVEL (FILL)
- SILT
- SUBAQUEOUS SAND
- SILT/CLAY/SAND/GRAVEL (TILL)
- BOULDERS/COBBLES
- BEDROCK
- OVERBURDEN POTENTIOMETRIC SURFACE - NON-PUMPING CONDITIONS - JUNE 6, 2001
- OVERBURDEN POTENTIOMETRIC SURFACE - NORTHERN EXTRACTION WELLS PUMPING - JUNE 22, 2001
- SHALLOW BEDROCK POTENTIOMETRIC SURFACE - NORTHERN EXTRACTION WELLS PUMPING - JUNE 22, 2001

FEATURE LEGEND:



DRAWN BY: J.P. / R.G.D.	TITLE: GEOLOGICAL CROSS-SECTION A-A' EASTERN SURPLUS CO. SITE MEDDYBEMPS, MAINE		TETRA TECH NUS, INC.
PREPARED BY: C. RACE		W.A.NO.: 015-RICO-0189	55 JONSPIN ROAD WILMINGTON, MASSACHUSETTS 01887 (978)658-7899
CHECKED BY: C. RACE	SCALE: AS SHOWN	DATE: DECEMBER 2002	PROJ. NO: 4112.0760
PROJECT MANAGER: L. CHU	DRAWING NO: FIGURE 3-2	ACFILE NAME: D:\PC\4112\0760\PG_3-2_GCS.DWG	REV: 0
PROGRAM MANAGER: G. GARDNER			

SECTION B-B'

B

B'

MW-19S
RWS-8
RWS-7
RWS-6/MW-2S
MW-3S/RWS-5
RWS-4
RWS-3
MW-30S
RWS-2
RWS-1
MW-11B
MW-11S

6
6
26
13
1U
1U

EOB @ 103 FT
EOS @ 111 FT
EOB @ 111 FT
EOS @ 79 FT
EOB @ 116 FT
OPEN BOREHOLE TO 132 FT

180
170
160
150
140
130
120
110
100

1. THE DEPTH, THICKNESS, AND CONTINUITY OF THE SUBSURFACE MATERIALS INDICATED ON THE PROFILES WERE GENERALIZED FROM, AND INTERPOLATED BETWEEN SUBSURFACE BORINGS FROM DATA REPORTED ON BORING LOGS. INFORMATION REGARDING SUBSURFACE CONDITIONS AND WATER LEVELS EXISTS ONLY AT THE SPECIFIC LOCATION OF EACH BORING AND AT THE TIME THE BORING WAS SAMPLED. THE LINES DEPICTING THE DISTRIBUTION OF THE SUBSURFACE MATERIALS REPRESENT AN ESTIMATED, APPROXIMATE BOUNDARY, AND THE ACTUAL BOUNDARIES MAY DIFFER FROM THOSE SHOWN. THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN SOIL CONDITIONS AND/OR WATER LEVELS FROM THOSE SHOWN.

2. PLAN NOT TO BE USED FOR DESIGN.

3. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.

4. LOCATIONS OF MW-3(B), MW-3(S), RW-2 WERE PROJECTED TO SECTION LINE.

LEGEND:

- SANDS/GRAVEL (FILL)
- SILT
- SUBAQUEOUS SAND
- SILT/CLAY/SAND/GRAVEL (TILL)
- BOULDERS/COBBLES
- BEDROCK
- OVERBURDEN POTENTIOMETRIC SURFACE – NON-PUMPING CONDITIONS – JUNE 6, 2001
- OVERBURDEN POTENTIOMETRIC SURFACE – SOUTHERN EXTRACTION WELLS PUMPING – JUNE 11, 2001

FEATURE LEGEND:

FEATURE
GROUND SURFACE ELEVATION
FRACTURE ZONE
SCREENED INTERVAL
110 PCE CONCENTRATION IN µg/L – JUNE 2001
END OF SCREEN (EOS)
END OF BORING (EOB)

GRAPHIC SCALE
40' 0' 40' 80'
HORIZONTAL SCALE:
10' 0' 20' 30'
VERTICAL SCALE:

DRAWN BY: J.P. / R.G.D.	TITLE: GEOLOGICAL CROSS-SECTION B-B' EASTERN SURPLUS CO. SITE MEDDYBEMPS, MAINE		
PREPARED BY: C. RACE		W.A.NO.: 015-RICO-0189	
CHECKED BY: C. RACE	SCALE: AS SHOWN	DATE: DECEMBER 2002	PROJ. NO: 4112.0760
PROJECT MANAGER: L. CHU	DRAWING NO: FIGURE 3-3	ACFILE NAME: DWG\4112\0760\VSC_3-3_XCS.DWG	REV: 0
PROGRAM MANAGER: G. GARDNER			

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55 JONSPIN ROAD
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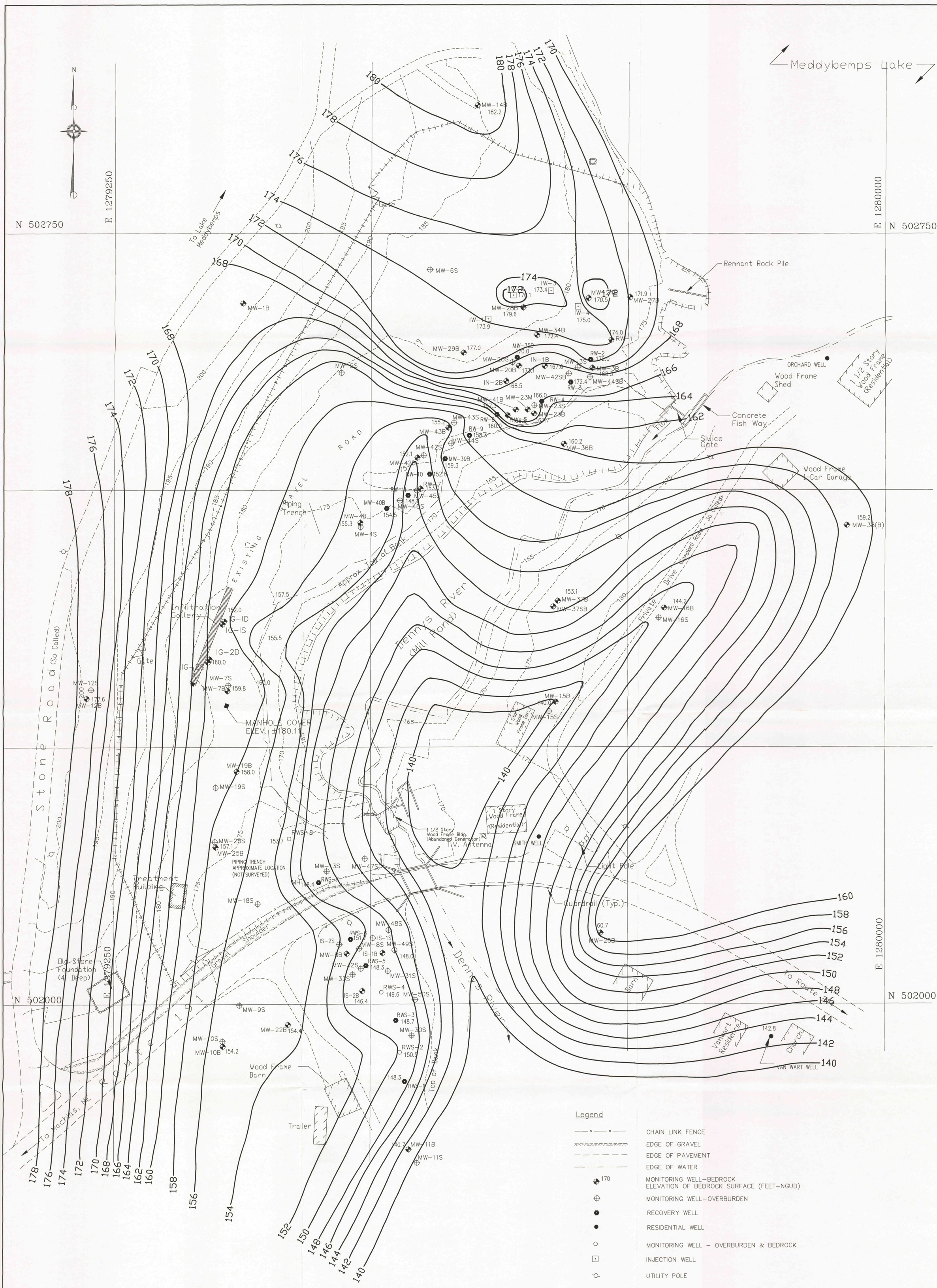
(978)658-7899



Legend

- CHAIN LINK FENCE
- EDGE OF GRAVEL
- EDGE OF PAVEMENT
- EDGE OF WATER
- 170 — MONITORING WELL–BEDROCK ELEVATION OF BEDROCK SURFACE (FEET–NGUD)
- MONITORING WELL–OVERBURDEN
- RECOVERY WELL
- RESIDENTIAL WELL
- MONITORING WELL – OVERBURDEN & BEDROCK
- INJECTION WELL
- UTILITY POLE
- 172 — INTERPRETED BEDROCK SURFACE CONTOUR (FEET–NGVD)

1. ELEVATIONS ARE BASED ON U.S.G.S. (NGVD 1929) MEAN SEA LEVEL.
2. BEARINGS ARE BASED ON MAINE STATE GRID COORDINATE SYSTEM (EAST ZONE) "NAD 83". DISTANCES SHOWN ARE GROUND DISTANCES AND ARE NOT REDUCED BY GRID AND ELEVATION FACTORS. CONTROL STATIONS USED: GREEN.....N = 499787.956 E = 1270274.069 ALEX.....N = 502946.205 E = 1254863.930
3. WELLS MW–47S TO MW–50S LOCATIONS APPROXIMATE, ALL OTHER WELL LOCATIONS SURVEYED.
4. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
5. PLAN NOT TO BE USED FOR DESIGN.

GRAPHIC SCALE
40' 0' 40' 80'

DRAWN BY: D.W. MACDOUGALL
PREPARED BY: C. RACE
CHECKED BY: C. RACE
PROJECT MANAGER: L. CHU
PROGRAM MANAGER: G. GARDNER

TITLE: BEDROCK SURFACE MAP
EASTERN SURPLUS CO. SITE – MEDDYBEMPS, MAINE

SOURCE: TOPOGRAPHIC/INSTRUMENT SURVEY PERFORMED BY OEST ASSOC. INC. DATED, OCTOBER 1996; UPDATED: JAN. 2000, APR. 2001

SCALE:	DATE:	PROJ. NO:
AS SHOWN	JANUARY 2003	4112
DRAWING NO: FIGURE 3–4	ACFILE NAME: DWG\4112\0760\FIG_3-4_01-03.DWG	REV: 0

TETRA TECH NUS, INC.
55 JONSPIN ROAD
WILMINGTON, MASSACHUSETTS 01887
(978)658–7899

N

ROSE DIAGRAM
N =29
STEREONET
1 pt. (3.45%)
> 3%
> 6%
> 12%
> 24%
(Max.= 31.03%)

ROSE DIAGRAM
N =27
STEREONET
1 pt. (3.70%)
> 3%
> 6%
> 12%
> 24%
(Max.= 25.93%)

ROSE DIAGRAM
N =20
STEREONET
1 pt. (5.00%)
> 5%
> 10%
(Max.= 15.00%)

ROSE DIAGRAM
N =25
STEREONET
1 pt. (4.00%)
> 4%
> 8%
(Max.= 16.00%)

ROSE DIAGRAM
N =49
STEREONET
1 pt. (2.04%)
> 2%
> 4%
> 8%
(Max.= 14.29%)

ROSE DIAGRAM
N =35
STEREONET
1 pt. (2.86%)
> 2%
> 4%
> 8%
> 16%
(Max.= 17.14%)

ROSE DIAGRAM
N =43
STEREONET
1 pt. (2.33%)
> 2%
> 4%
> 8%
(Max.= 16.28%)

ROSE DIAGRAM
N =28
STEREONET
1 pt. (3.57%)
> 3%
> 6%
> 12%
(Max.= 21.43%)

ROSE DIAGRAM
N =37
STEREONET
1 pt. (2.70%)
> 2%
> 4%
> 8%
(Max.= 13.51%)

ROSE DIAGRAM
N =51
STEREONET
1 pt. (1.96%)
> 1%
> 2%
> 4%
> 8%
> 16%
(Max.= 17.65%)

ROSE DIAGRAM
N =61
STEREONET
1 pt. (1.64%)
> 1%
> 2%
> 4%
> 8%
(Max.= 9.84%)

ROSE DIAGRAM
N =72
STEREONET
1 pt. (1.39%)
> 1%
> 2%
> 4%
> 8%
(Max.= 13.89%)

ROSE DIAGRAM
N =80
STEREONET
1 pt. (1.25%)
> 1%
> 2%
> 4%
> 8%
(Max.= 10.00%)

ROSE DIAGRAM
N =72
STEREONET
1 pt. (1.39%)
> 1%
> 2%
> 4%
> 8%
(Max.= 16.67%)

ROSE DIAGRAM
N =32
STEREONET
1 pt. (3.13%)
> 3%
> 8%
(Max.= 9.38%)

ROSE DIAGRAM
N =75
STEREONET
1 pt. (1.33%)
> 1%
> 2%
> 4%
> 8%
> 16%
(Max.= 21.33%)

ROSE DIAGRAM
N =35
STEREONET
1 pt. (2.86%)
> 2%
> 4%
> 8%
> 32%
(Max.= 42.86%)

ROSE DIAGRAM
N =82
STEREONET
1 pt. (1.22%)
> 1%
> 2%
> 4%
> 8%
> 16%
(Max.= 24.39%)

ROSE DIAGRAM
N =40
STEREONET
1 pt. (2.50%)
> 2%
> 4%
> 8%
> 16%
(Max.= 30.00%)

COMPOSITES
ROSE DIAGRAM
N =893
STEREONET
> 1%
> 2%
> 4%
> 8%
(Max.= 9.29%)

Meddybemps Lake
To Lake Meddybemps
Gate
Remnant Rock Pile
ROAD
GRAVEL
EXISTING
Infiltration Gallery
Approx. Top of Bank
Dennys River (Mill Pond)
Private Drive (Campbell Road So Called)
Stone Road (So Called)
Route 191
To Machias, ME
To Route 214
Concrete Fish Way
Sluice Gate
Flow
Wood Frame Shed
ORCHARD WELL
Wood Frame Barn
MANHOLE COVER ELEV. 180.11
1 Story Wood Frame Gar.
1 Story Wood Frame (Residential)
1 1/2 Story Wood Frame Bldg. (Abandoned Generator)
T.V. Antenna
SMITH WELL
Light Pole
Guardrail (Typ.)
Old Stone Foundation (4' Deep)
Gravel Shoulder
Top of Bank
Trailer
Barn
Vanwart Residence
Church
VAN WART WELL
MH

MW-1B MW-4B MW-4S MW-5S MW-6S MW-7S MW-7B MW-9S MW-10S MW-10B MW-11B MW-11S MW-12S MW-12B MW-13S MW-14B MW-15S MW-15B MW-16S MW-16B MW-18S MW-19B MW-19S MW-20S MW-20B MW-22B MW-23M MW-23S MW-23B MW-24B MW-25S MW-25B MW-26B MW-27B MW-28B MW-29B MW-31S MW-32S MW-33S MW-34B MW-35B MW-36B MW-37B MW-37SB MW-38(B) MW-39B MW-40B MW-41B MW-42B MW-42S MW-43B MW-43S MW-44S MW-45S MW-46S MW-47S MW-48S MW-49S MW-50S

IW-1B IW-2B IW-3B IW-4B IN-1B IN-2B

IS-1B IS-2B

RW-1 RW-2 RW-3 RW-4 RW-5 RW-7 RW-8 RW-9 RW-10 RW-11

RWS-2 RWS-3 RWS-4 RWS-5 RWS-6 RWS-7 RWS-8

MW-3S MW-3B MW-42SB MW-44SB

IG-1B IG-2B IG-2D

Legend

- CHAIN LINK FENCE
- EDGE OF GRAVEL
- EDGE OF PAVEMENT
- EDGE OF WATER
- MONITORING WELL-BEDROCK
- MONITORING WELL-OVERBURDEN
- RECOVERY WELL
- RESIDENTIAL WELL
- MONITORING WELL - OVERBURDEN & BEDROCK
- INJECTION WELL
- UTILITY POLE

* WELLS IN BLACK INDICATE ROSE DIAGRAMS AND STEREONETS.

NOTES:

1. ELEVATIONS ARE BASED ON U.S.G.S. (NGVD 1929) MEAN SEA LEVEL.
2. BEARINGS ARE BASED ON MAINE STATE GRID COORDINATE SYSTEM (EAST ZONE) "NAD 83". DISTANCES SHOWN ARE GROUND DISTANCES AND ARE NOT REDUCED BY GRID AND ELEVATION FACTORS. CONTROL STATIONS USED:
GREEN.....N = 499787.956 E = 1270274.069 ALEX.....N = 502946.205 E = 1254863.930
3. WELLS MW-47S TO MW-50S LOCATIONS APPROXIMATE, ALL OTHER WELL LOCATIONS SURVEYED.
4. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
5. PLAN %%uNOT%%u TO BE USED FOR DESIGN.

40 0 40 Feet

DRAWN BY: J. PICCUITO / R.G. DEWSNAP
PREPARED BY: C. RACE
CHECKED BY: C. RACE
PROJECT MANAGER: L. CHU
PROGRAM MANAGER: G. GARDNER

TITLE: FRACTURE ROSE DIAGRAMS AND STEREONETS
EASTERN SURPLUS CO. SITE - MEDDYBEMPS, MAINE

SOURCE: TOPOGRAPHIC/INSTRUMENT SURVEY PERFORMED BY OEST ASSOC. INC. DATED, OCTOBER 1996; UPDATED: JAN. 2000, APR. 2001

SCALE: AS SHOWN
DATE: JANUARY 2003
PROJ. NO: N4112
DRAWING NO: FIGURE 3-5
AVFILE NAME: EASTERN\4112\0640\0640A.APR (12-2002)
REV: 1

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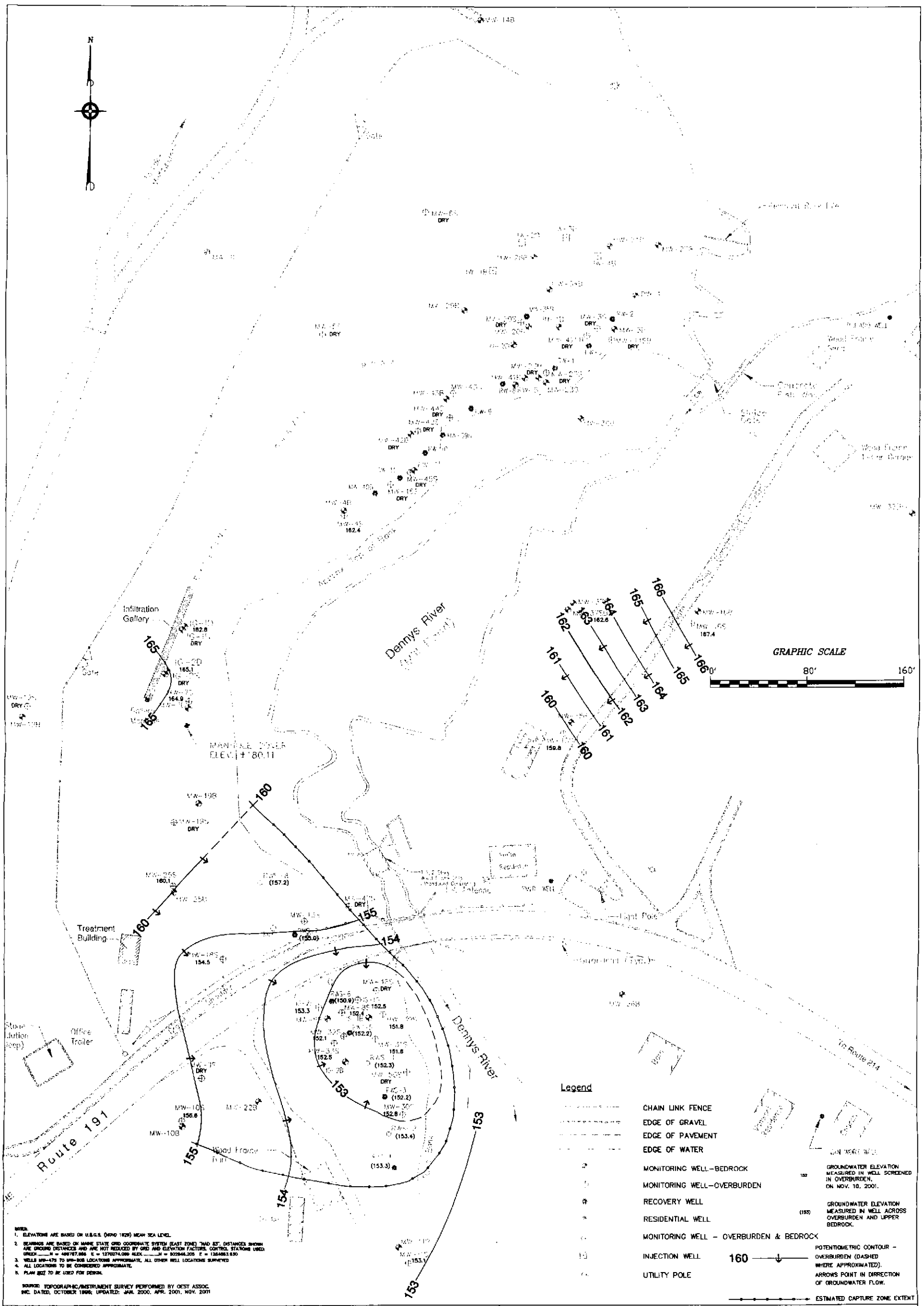
(978)658-7899



NOTES:
1. ELEVATIONS ARE BASED ON U.S.G.S. (NGVD 1929) MEAN SEA LEVEL.
2. BEARINGS ARE BASED ON MAINE STATE GRID COORDINATE SYSTEM (EAST ZONE) "NAD 83". DISTANCES SHOWN ARE GROUND DISTANCES AND ARE NOT REDUCED BY GRID AND ELEVATION FACTORS. CONTROL STATIONS USED: ORIEN ..... N = 486787.986 E = 1270074.089 ALEX ..... N = 502944.205 E = 1264883.830
3. WELLS MW-47S TO MW-80S LOCATIONS APPROXIMATE, ALL OTHER WELL LOCATIONS SURVEYED
4. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
5. PLAN NOT TO BE USED FOR DESIGN.

SOURCE: TOPOGRAPHIC/INSTRUMENT SURVEY PERFORMED BY GEST ASSOC. INC. DATED, OCTOBER 1998; UPDATED: JAN. 2000, APR. 2001, NOV. 2001

OVERBURDEN POTENTIOMETRIC SURFACE–NOV. 10, 2001

EASTERN SURPLUS CO. SITE

MEDDYBEMPS MAINE

FIGURE 3–6

DRAWN BY:	J. PICCUITO	REV.:	0
CHECKED BY:	L. CHU	DATE:	DECEMBER 2001
SCALE:		FILE NO.:	D:\DWG\4112\0760\FIG3_6.DWG

TETRA TECH NUS, INC.
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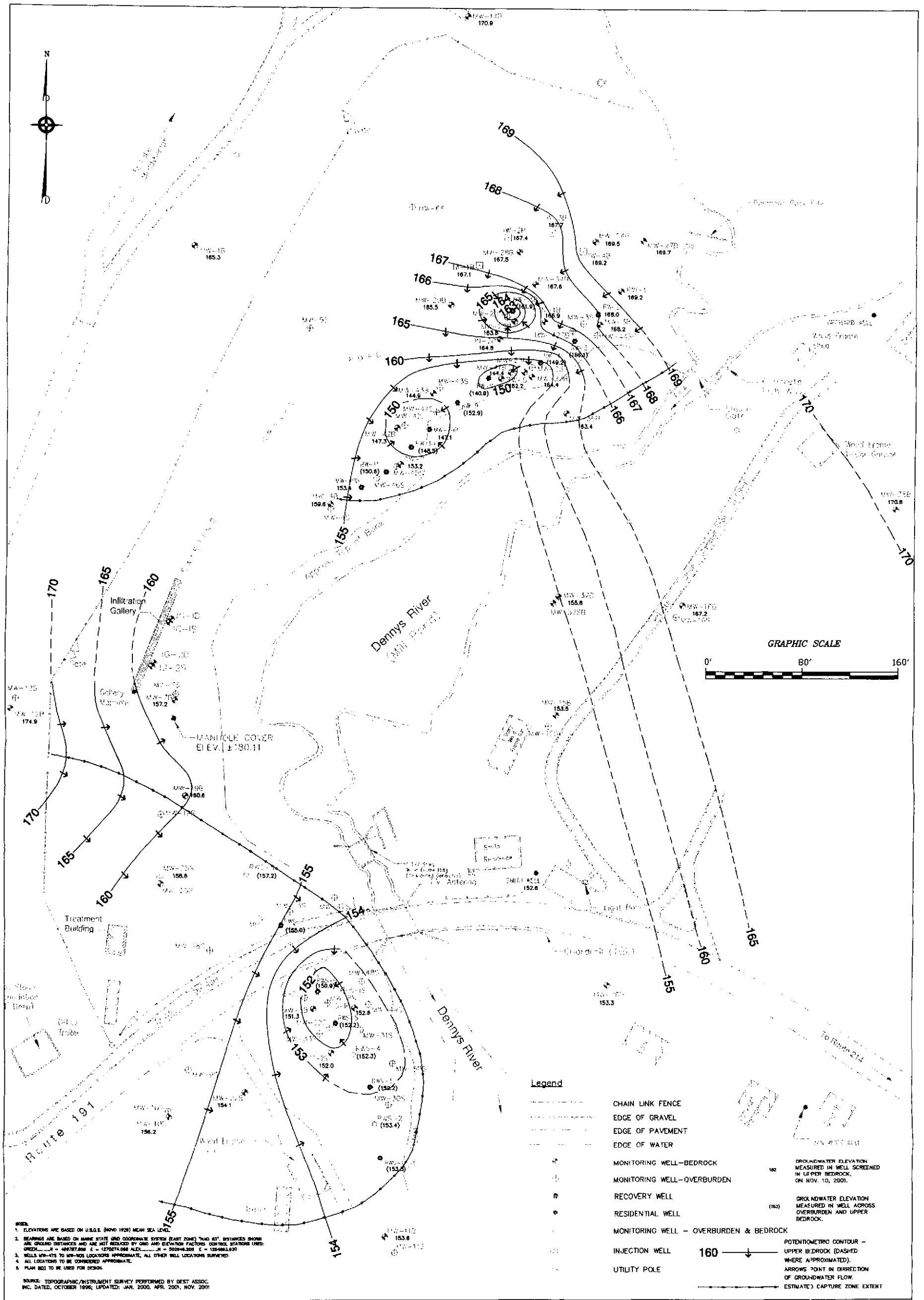
(978)658-7899



UPPER BEDROCK POTENTIOMETRIC SURFACE-NOV. 10, 2001

EASTERN SURPLUS CO. SITE

MEDDYBEMPS MAINE

FIGURE 3-7

DRAWN BY:	J. PICCUITO	REV.:	0
CHECKED BY:	L. CHU	DATE:	DECEMBER 2001
SCALE:		FILE NO.:	D:\DWG\4112\0760\FIG3_7.DWG

TETRA TECH NUS, INC.
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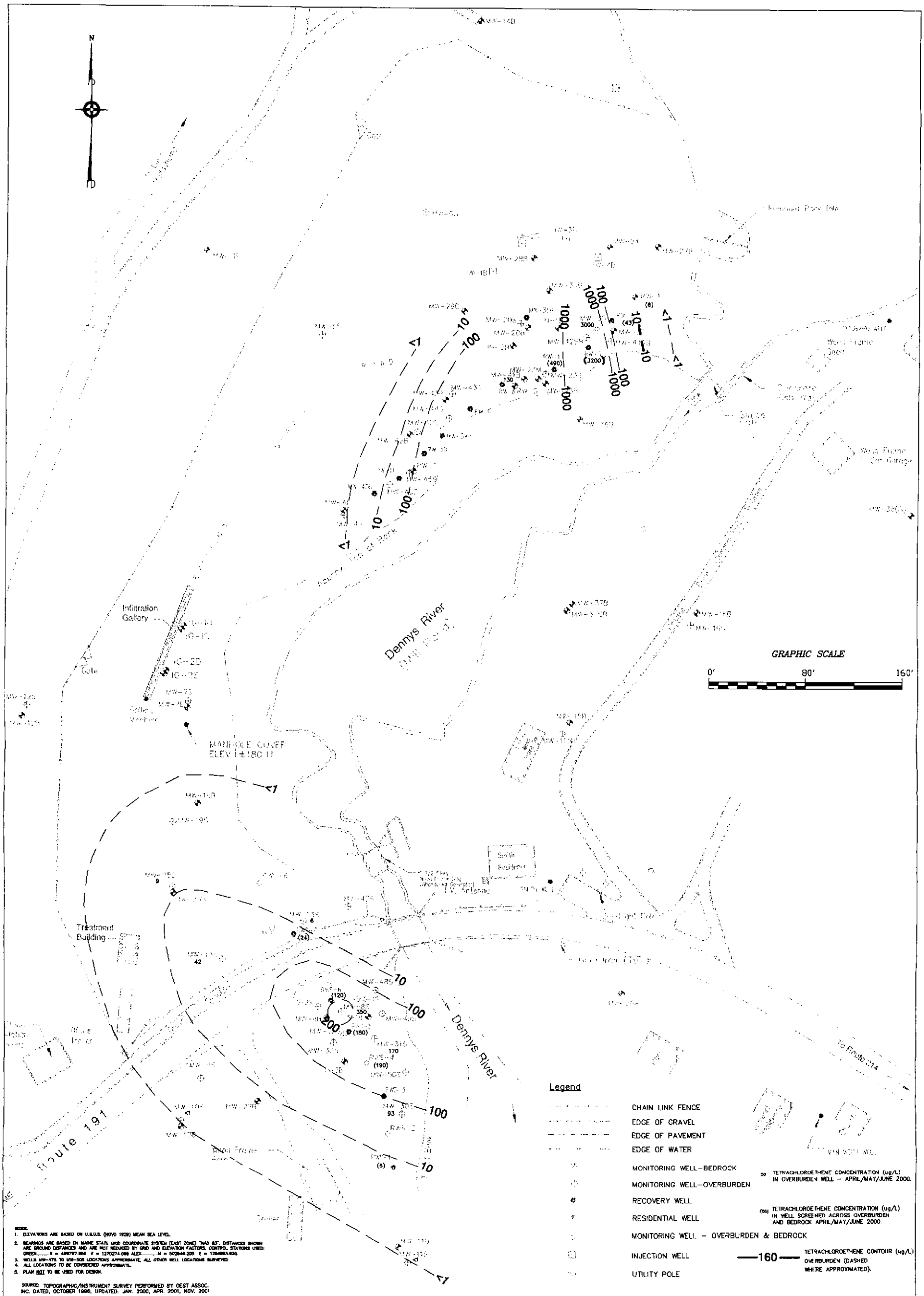
(978)658-7899



TETRACHLOROETHENE IN OVERBURDEN AQUIFER – APRIL/MAY/JUNE 2000

FIGURE 3-8

EASTERN SURPLUS CO. SITE

MEDDYBEMPS MAINE

DRAWN BY:	J. PICCUITO	REV.:	0
CHECKED BY:	L. CHU	DATE:	FEBRUARY 2002
SCALE:		FILE NO.:	D:\DWG\4112\0760\FIG3_8.DWG

TETRA TECH NUS, INC.
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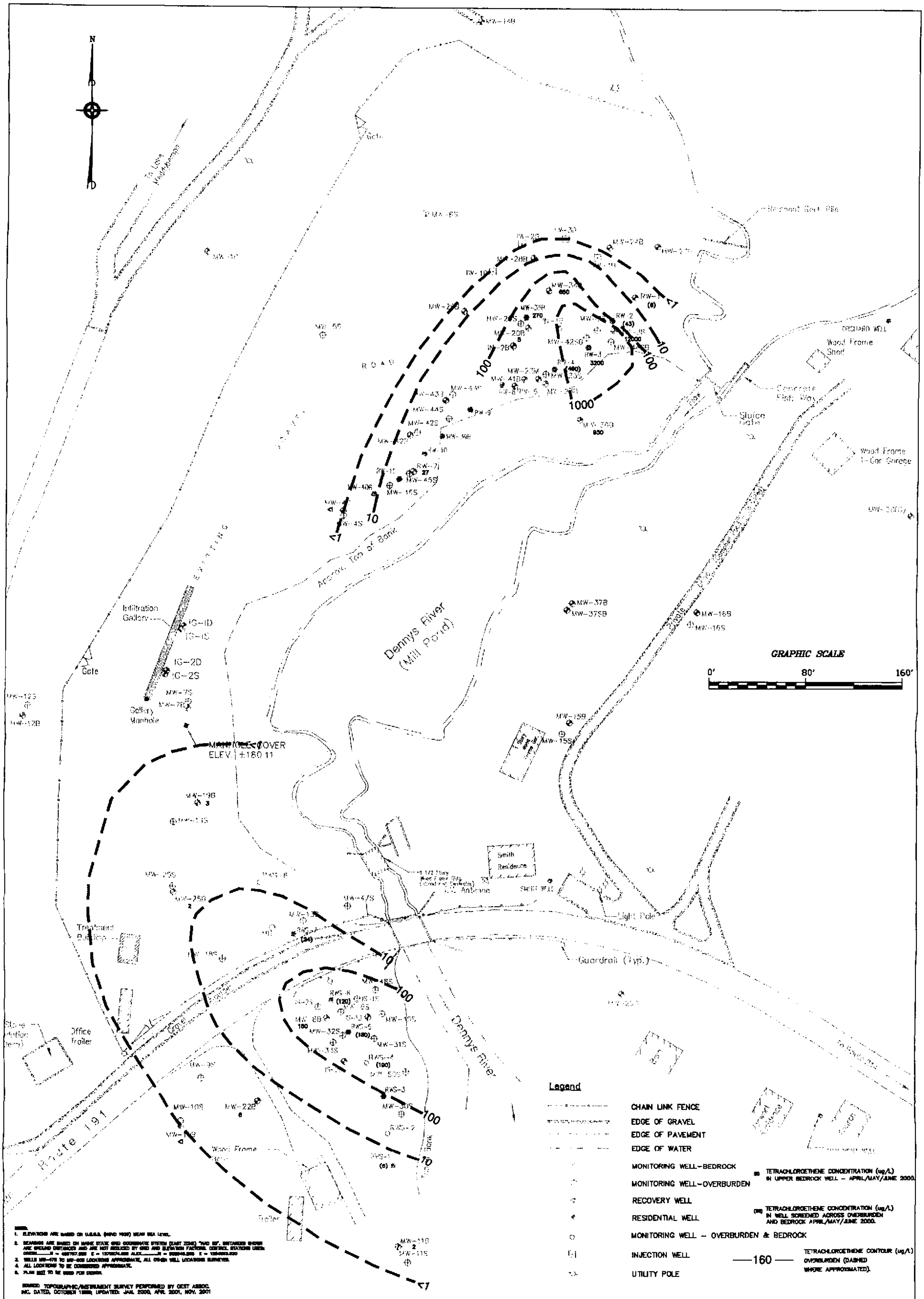
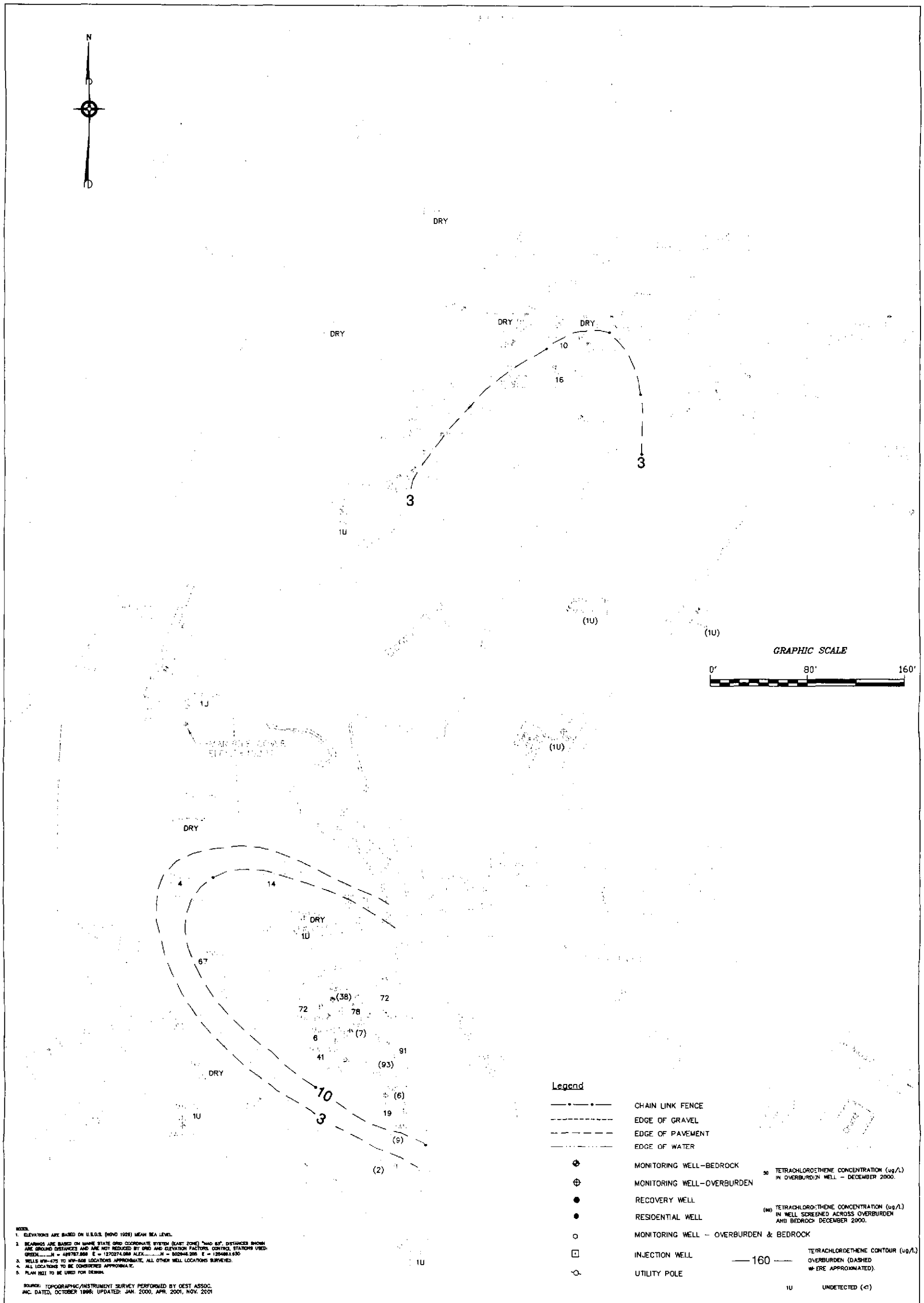
(978)658-7899



TETRACHLOROETHENE IN UPPER BEDROCK AQUIFER – APRIL/MAY/JUNE 2000			FIGURE 3-9
EASTERN SURPLUS CO. SITE			
MEDDYBEMPS MAINE			TETRA TECH NUS, INC.
DRAWN BY: J. PICCUITO		REV.: 0	
CHECKED BY: L. CHU		DATE: FEBRUARY 2002	55 Jonspin Road Wilmington, MA 01887
SCALE:		FILE NO.: D:\DWG\4112\0760\FIG3_9.DWG	(978)658-7899



NOTES:
1. ELEVATIONS ARE BASED ON U.S.G.S. (NGVD 1929) MEAN SEA LEVEL.
2. BEARINGS ARE BASED ON MAINE STATE GRID COORDINATE SYSTEM (EAST ZONE) "NAD 83". DISTANCES SHOWN ARE GROUND DISTANCES AND ARE NOT REDUCED BY GRID AND ELEVATION FACTORS. CONTROL STATIONS USED: GREEN.....N = 499787.869 E = 1270274.089 ALEX.....N = 502944.295 E = 1264883.930
3. WELLS MW-475 TO MW-508 LOCATIONS APPROXIMATE, ALL OTHER WELL LOCATIONS SURVEYED.
4. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
5. PLAN NOT TO BE USED FOR DESIGN.

SOURCE: TOPOGRAPHIC/INSTRUMENT SURVEY PERFORMED BY OEST ASSOC. INC. DATED, OCTOBER 1998; UPDATED: JAN. 2000, APR. 2001, NOV. 2001

TETRACHLOROETHENE IN OVERBURDEN AQUIFER - DECEMBER 2000

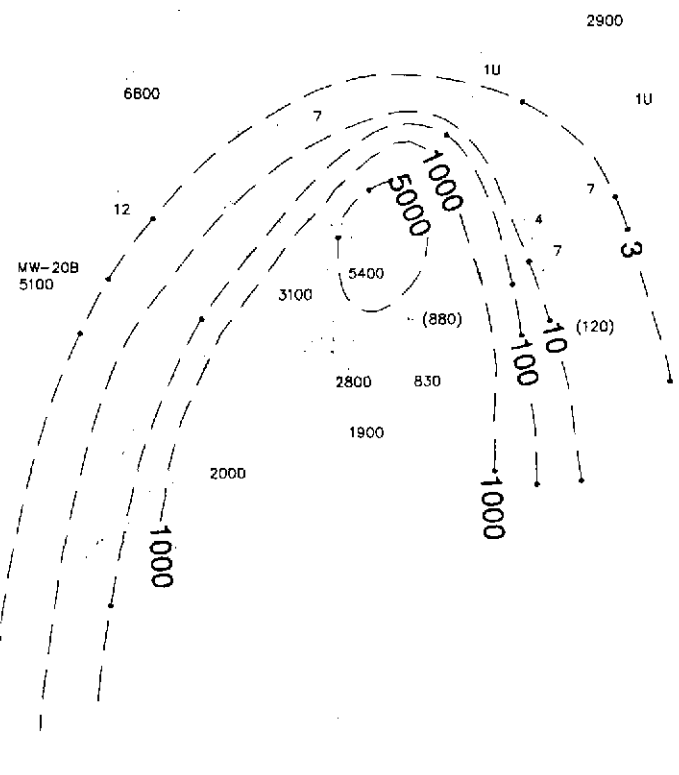
EASTERN SURPLUS CO. SITE

MEDDYBEMPS MAINE

DRAWN BY:	J. PICCUITO	REV.:	0
CHECKED BY:	L. CHU	DATE:	FEBRUARY 2002
SCALE:		FILE NO.:	D:\DWG\4112\0760\FIG4_1.DWG

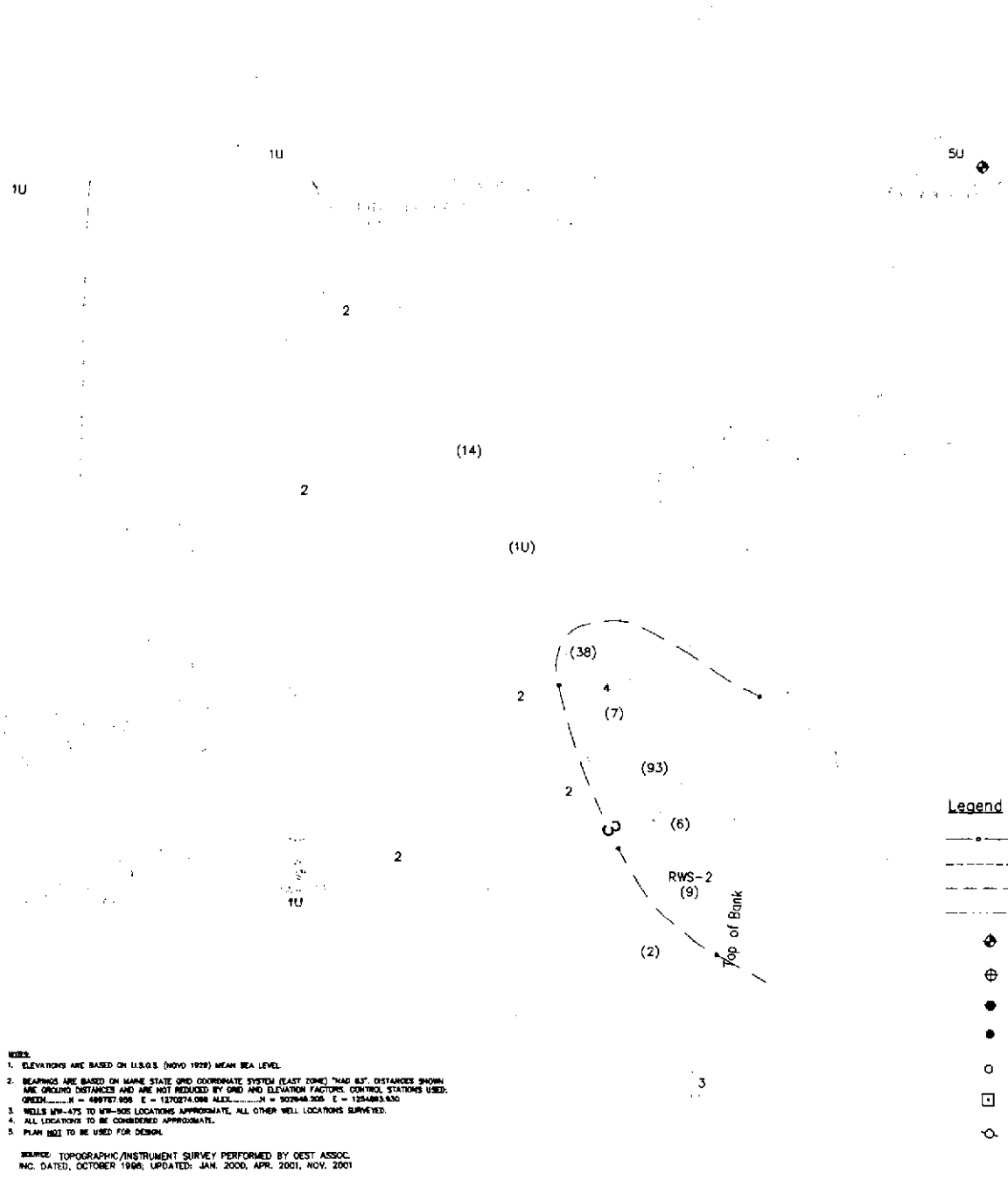
FIGURE 4-1

TETRA TECH NUS, INC.
55 Jonspin Road Wilmington, MA 01887
(978)658-7899



GRAPHIC SCALE

0' 80' 160'



Legend

- CHAIN LINK FENCE
- EDGE OF GRAVEL
- EDGE OF PAVEMENT
- EDGE OF WATER
- MONITORING WELL-BEDROCK
- MONITORING WELL-OVERBURDEN
- RECOVERY WELL
- RESIDENTIAL WELL
- MONITORING WELL - OVERBURDEN & BEDROCK
- INJECTION WELL
- UTILITY POLE
- 50 TETRACHLOROETHENE CONCENTRATION (ug/L) IN BEDROCK WELL - DECEMBER 2000.
- (50) TETRACHLOROETHENE CONCENTRATION (ug/L) IN WELL SCREENED ACROSS OVERBURDEN AND BEDROCK DECEMBER 2000.
- —160— TETRACHLOROETHENE CONTOUR (ug/L) OVERBURDEN (DASHED WHERE APPROXIMATED).
- 1U UNDETECTED (<1)

NOTES:
1. ELEVATIONS ARE BASED ON U.S.G.S. (NGVD 1929) MEAN SEA LEVEL
2. BEARINGS ARE BASED ON MAINE STATE GRID COORDINATE SYSTEM (EAST ZONE) "NAD 83". DISTANCES SHOWN ARE GROUND DISTANCES AND ARE NOT REDUCED BY GRID AND ELEVATION FACTORS. CONTROL STATIONS USED: GREEN.....N = 499787.906 E = 1270274.088 ALEX.....N = 502948.205 E = 1254883.630
3. WELLS MW-475 TO MW-505 LOCATIONS APPROXIMATE, ALL OTHER WELL LOCATIONS SURVEYED.
4. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
5. PLAN NOT TO BE USED FOR DESIGN.

SOURCE: TOPOGRAPHIC/INSTRUMENT SURVEY PERFORMED BY OEST ASSOC. INC. DATED, OCTOBER 1998; UPDATED: JAN. 2000, APR. 2001, NOV. 2001

TETRACHLOROETHENE IN BEDROCK AQUIFER - DECEMBER 2000

EASTERN SURPLUS CO. SITE

MEDDYBEMPS MAINE

FIGURE 4-2

DRAWN BY:	J. PICCUITO	REV.:	0
CHECKED BY:	L. CHU	DATE:	FEBRUARY 2002
SCALE:		FILE NO.:	D:\DWG\4112\0760\FIG4_2.DWG

TETRA TECH NUS, INC.

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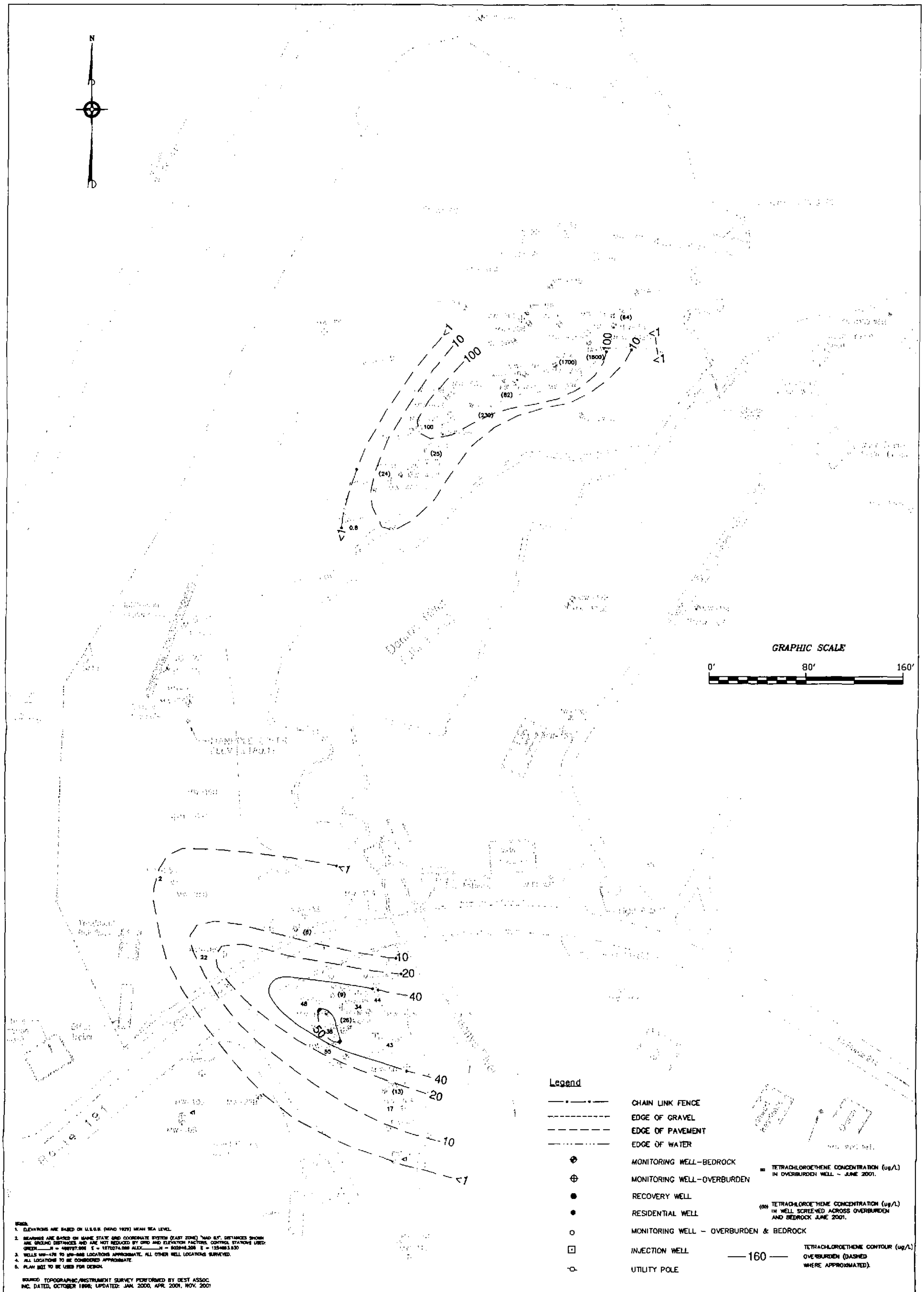
(978)658-7899

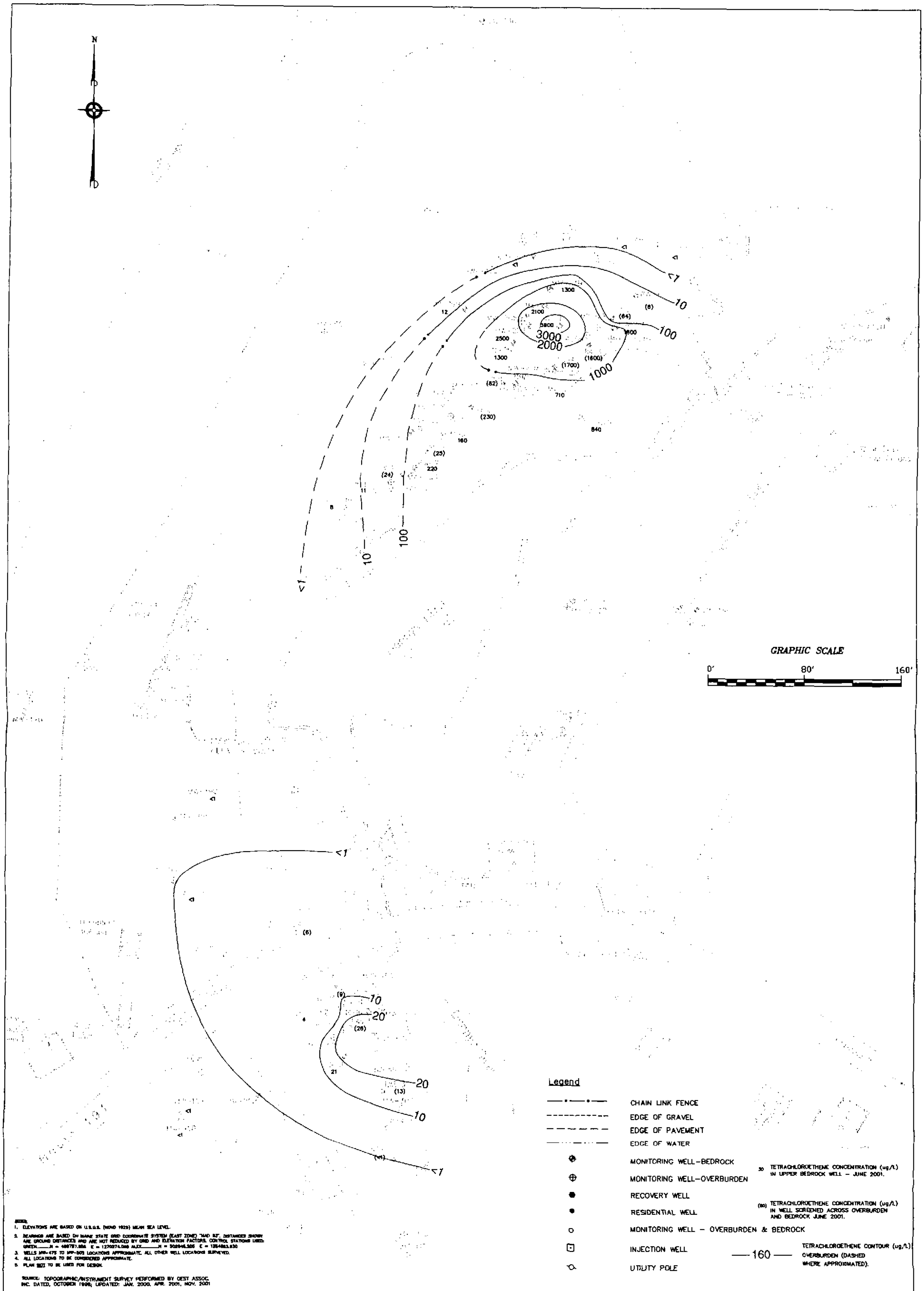


NOTES:

1. ELEVATIONS ARE BASED ON U.S.G.S. (NGVD 1929) MEAN SEA LEVEL.
2. BEARINGS ARE BASED ON MAINE STATE GRID COORDINATE SYSTEM (EAST ZONE) "NAD 83". DISTANCES SHOWN ARE GROUND DISTANCES AND ARE NOT REDUCED BY GRID AND ELEVATION FACTORS. CONTROL STATIONS USED: GREEN——N = 486787.908 E = 1270274.088 ALEX——N = 502846.206 E = 1254883.830
3. WELLS MW-47B TO MW-88B LOCATIONS APPROXIMATE. ALL OTHER WELL LOCATIONS SURVEYED.
4. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
5. PLAN NOT TO BE USED FOR DESIGN.

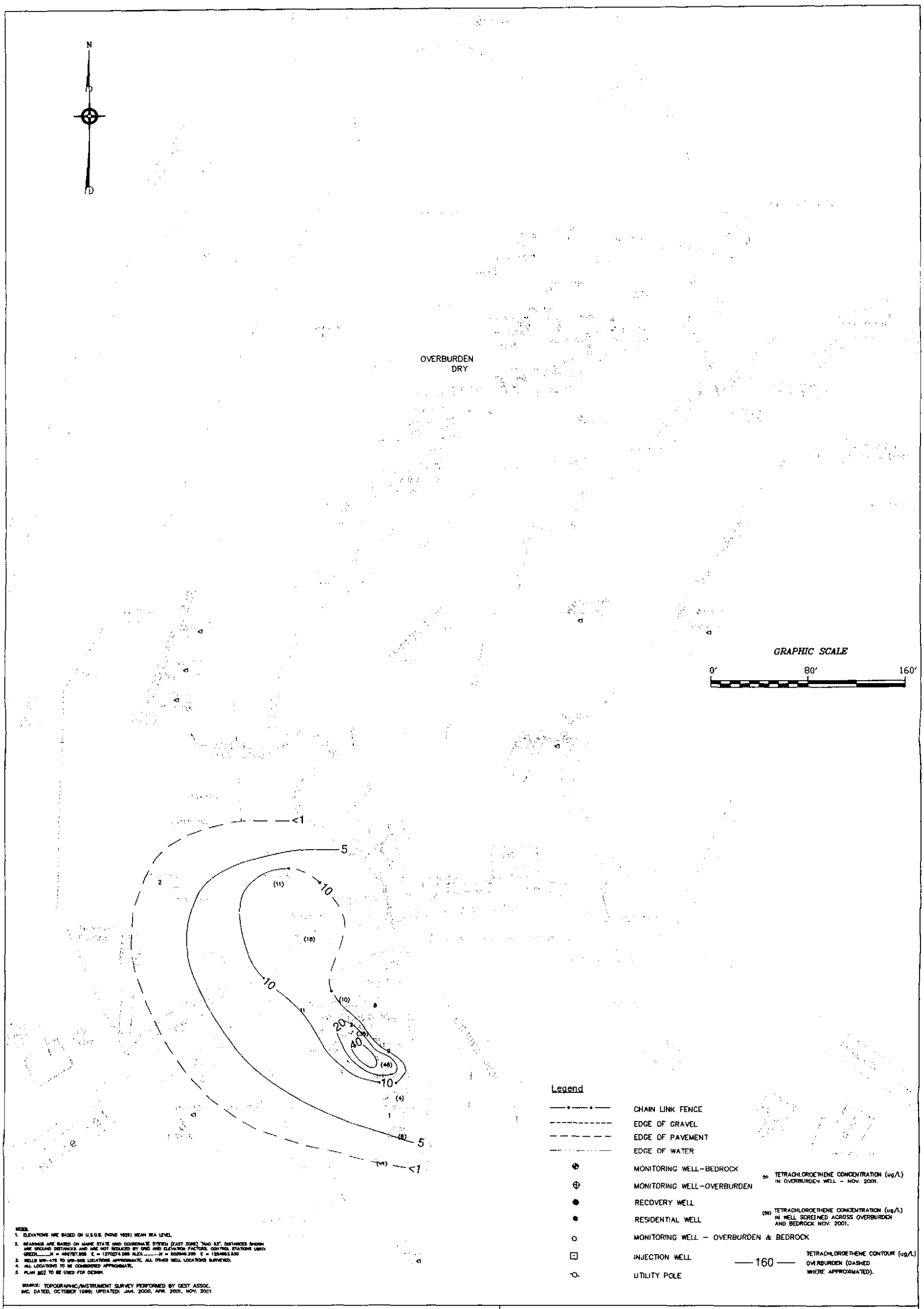
SOURCE: TOPOGRAPHIC/INSTRUMENT SURVEY PERFORMED BY DEST ASSOC. INC. DATED, OCTOBER 1998; UPDATED: JAN. 2000, APR. 2001, NOV. 2001

TETRACHLOROETHENE IN OVERBURDEN AQUIFER - JUNE 2001				FIGURE 4-3
EASTERN SURPLUS CO. SITE				TETRA TECH NUS, INC. 55 Jonspin Road Wilmington, MA 01887 (978)658-7899
MEDDYBEMPS MAINE				
DRAWN BY:	J. PICCUITO	REV.:	0	
CHECKED BY:	L. CHU	DATE:	FEBRUARY 2002	
SCALE:		FILE NO.:	D:\DWG\4112\0760\FIG4_3.DWG	



TETRACHLOROETHENE IN UPPER BEDROCK AQUIFER - JUNE 2001	FIGURE 4-4
EASTERN SURPLUS CO. SITE	TETRA TECH NUS, INC.
MEDDYBEMPS MAINE	55 Jonspin Road Wilmington, MA 01887 (978)658-7899

DRAWN BY:	J. PICCUITO	REV.:	0
CHECKED BY:	L. CHU	DATE:	FEBRUARY 2002
SCALE:		FILE NO.:	D:\DWG\4112\0760\FIG4_4.DWG



TETRACHLOROETHENE IN OVERBURDEN AQUIFER - NOV. 2001

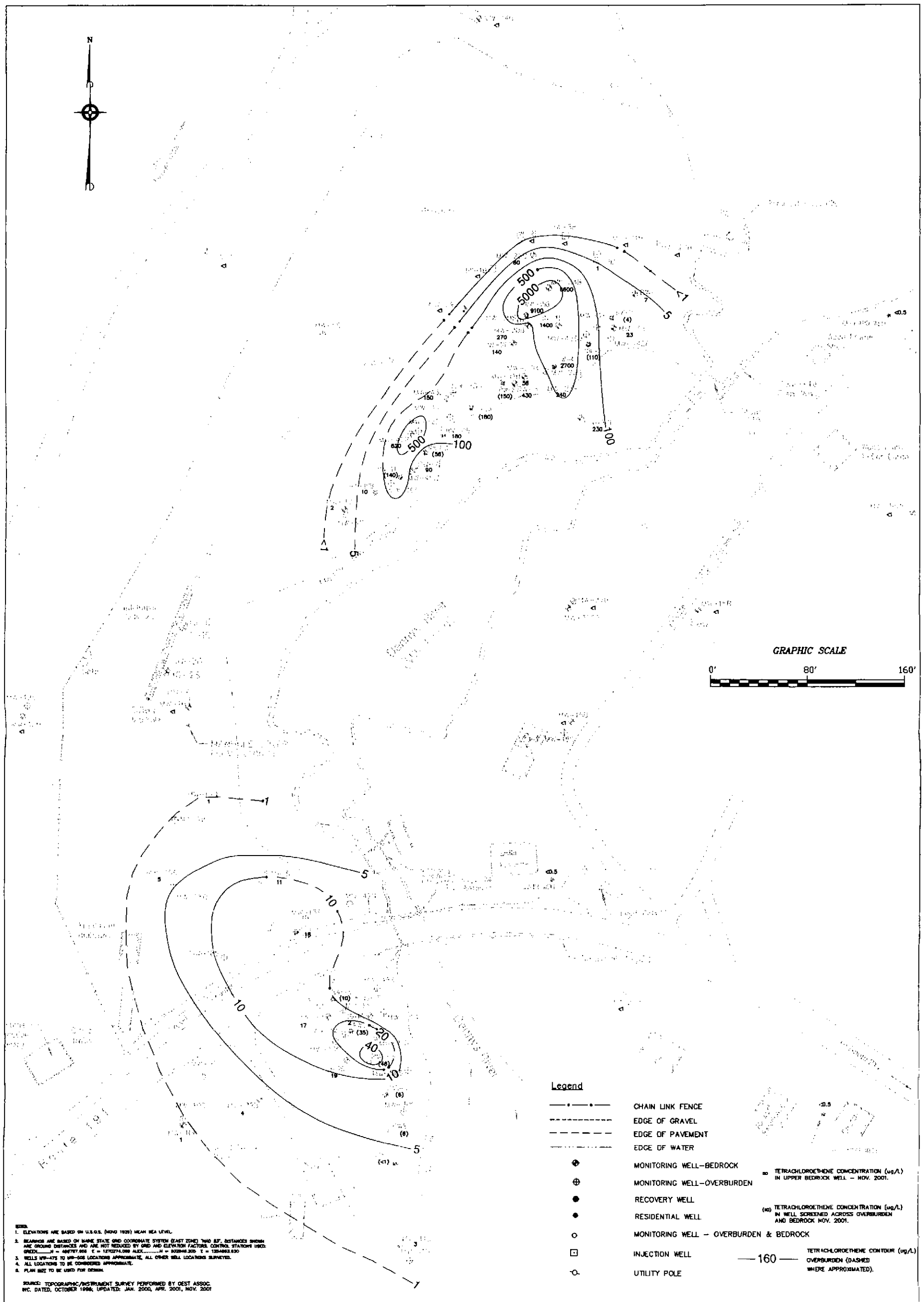
EASTERN SURPLUS CO. SITE

MEDDYBEMPS MAINE

FIGURE 4-5

DRAWN BY:	J. PICCUITO	REV.:	0
CHECKED BY:	L. CHU	DATE:	FEBRUARY 2002
SCALE:		FILE NO.:	D:\DWG\4112\0760\FIG4_5.DWG

TETRA TECH NUS, INC.
55 Jonspin Road Wilmington, MA 01887
(978)658-7899



TETRACHLOROETHENE IN UPPER BEDROCK AQUIFER - NOV. 2001

FIGURE 4-6

EASTERN SURPLUS CO. SITE

MEDDYBEMPS MAINE

DRAWN BY:	J. PICCUITO	REV.:	0
CHECKED BY:	L. CHU	DATE:	FEBRUARY 2002
SCALE:		FILE NO.:	D:\DWG\4112\0760\FIG4_6.DWG

TETRA TECH NUS, INC.
55 Jonspin Road Wilmington, MA 01887
(978)658-7899

FIGURE 4 - 7
PCE IN NORTHERN PLUME
SHALLOW BEDROCK WELLS
IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

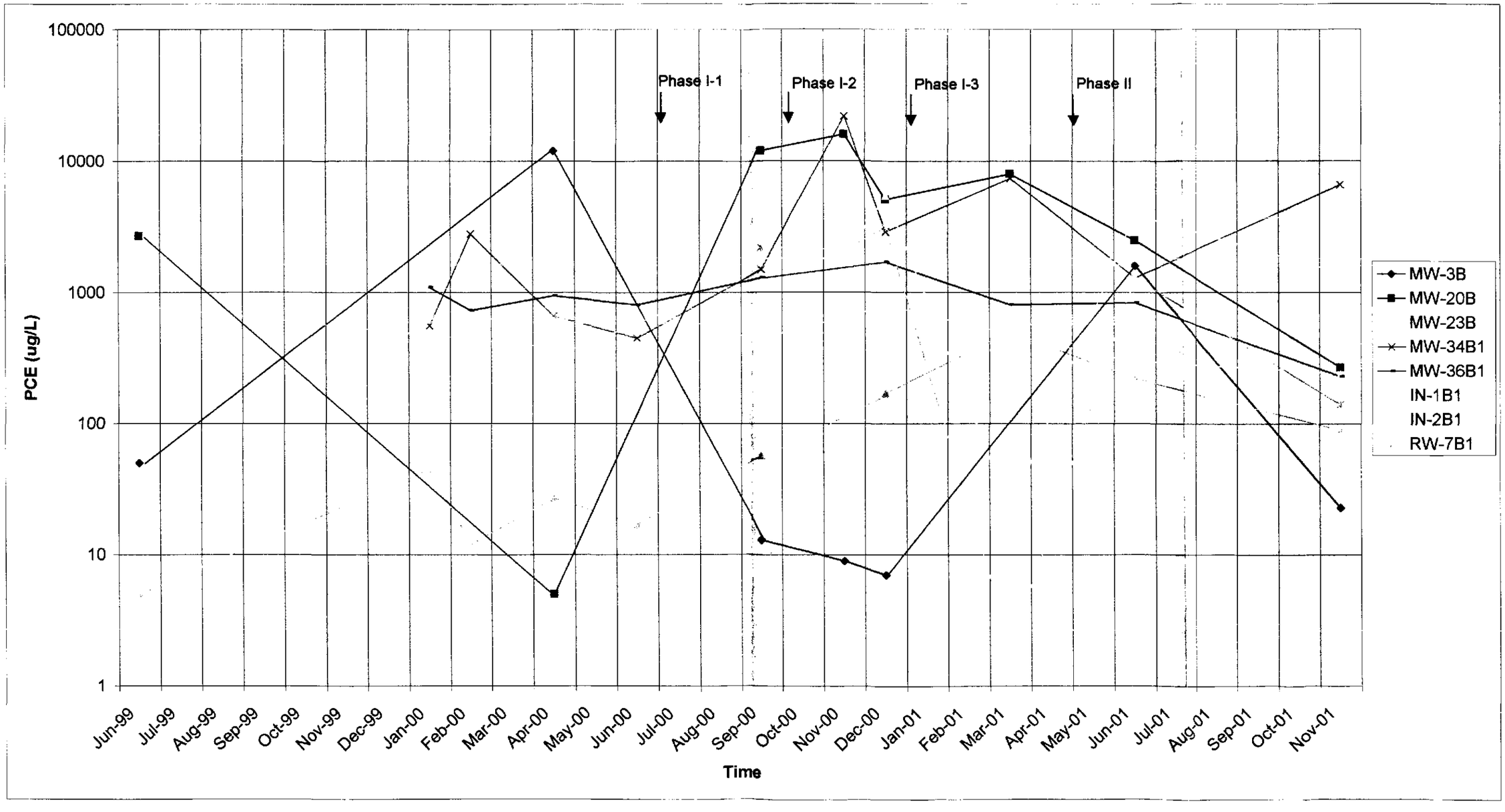


FIGURE 4 - 8
PCE IN NORTHERN PLUME DEEPER BEDROCK WELLS
IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

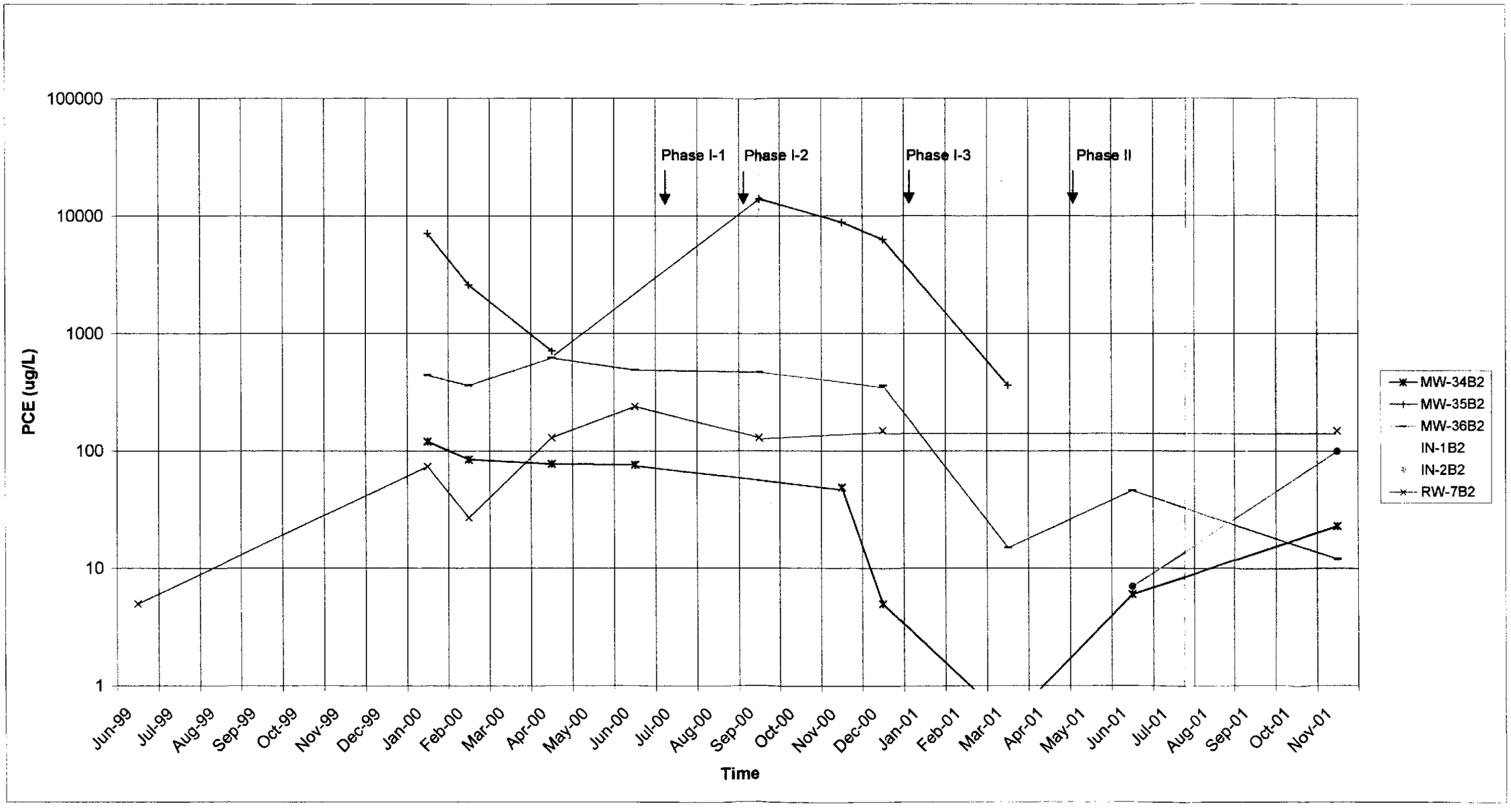


FIGURE 4 - 9
PCE IN NORTHERN PLUME RECOVERY WELLS
IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

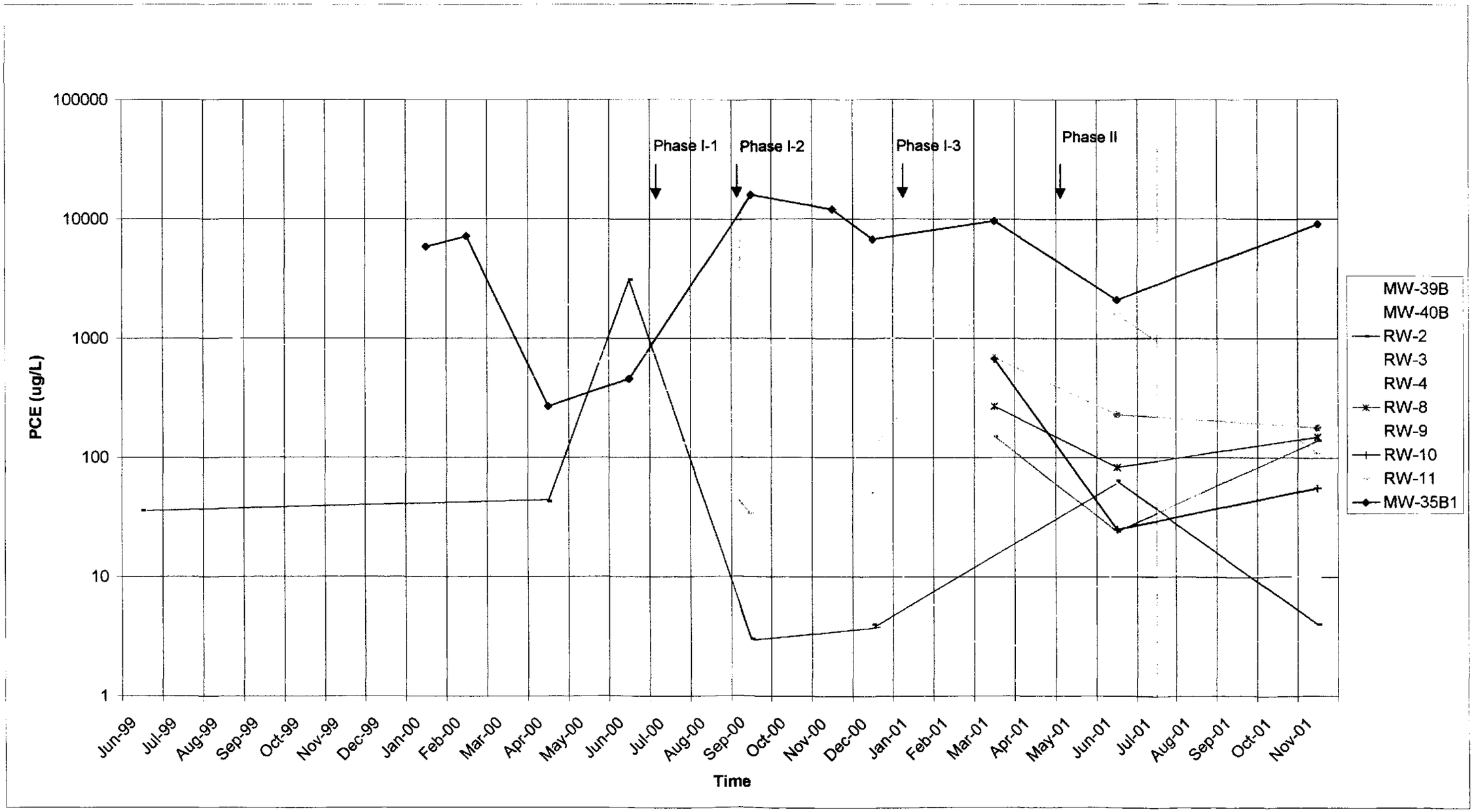
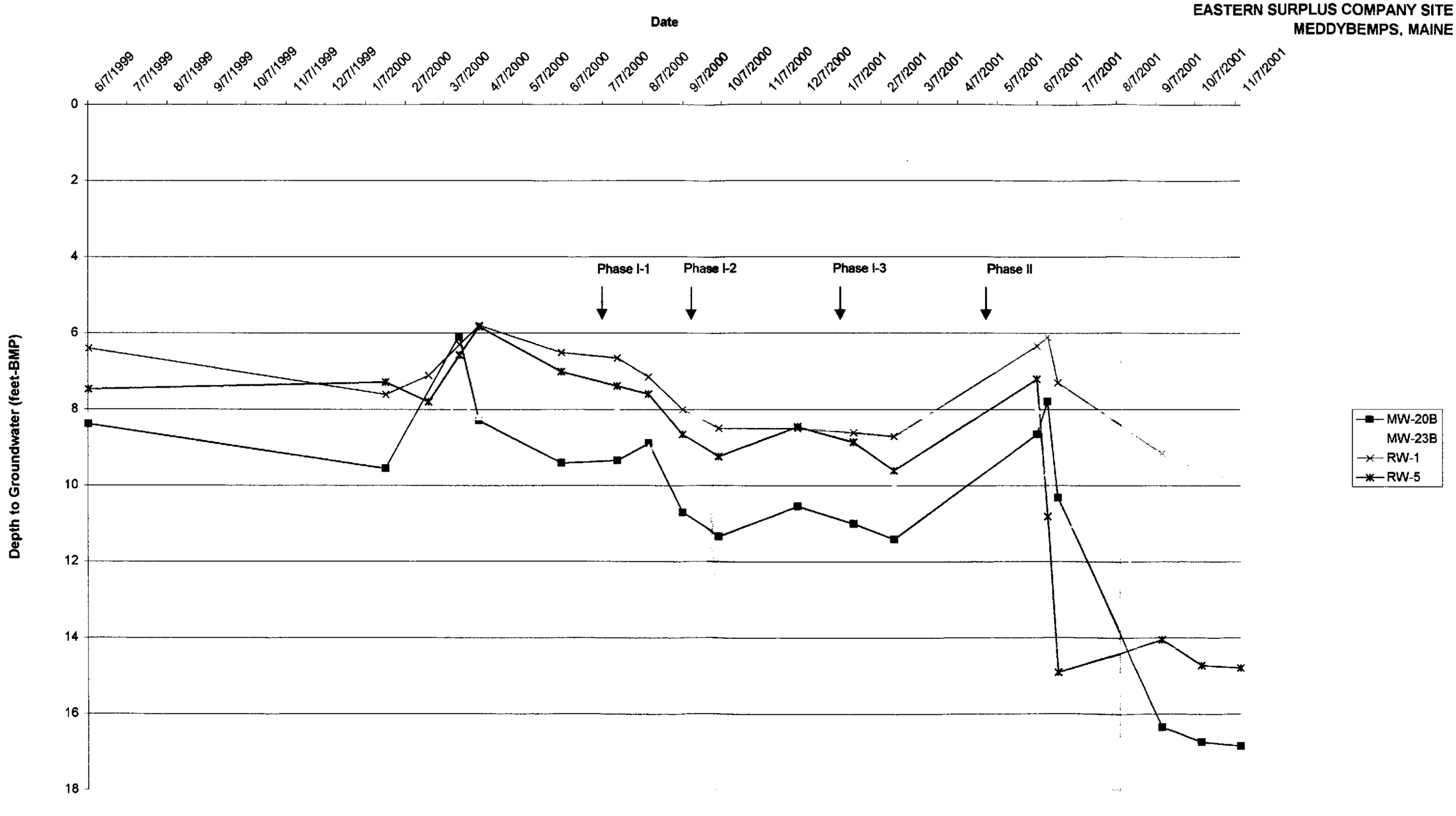


FIGURE 4 - 10
GROUNDWATER LEVEL TRENDS IN
SELECT NORTHERN PLUME WELLS
IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE



RI031005D

Tetra Tech NUS, Inc.

FIGURE 4 - 11
PCE IN SOUTHERN PLUME OVERBURDEN WELLS
IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

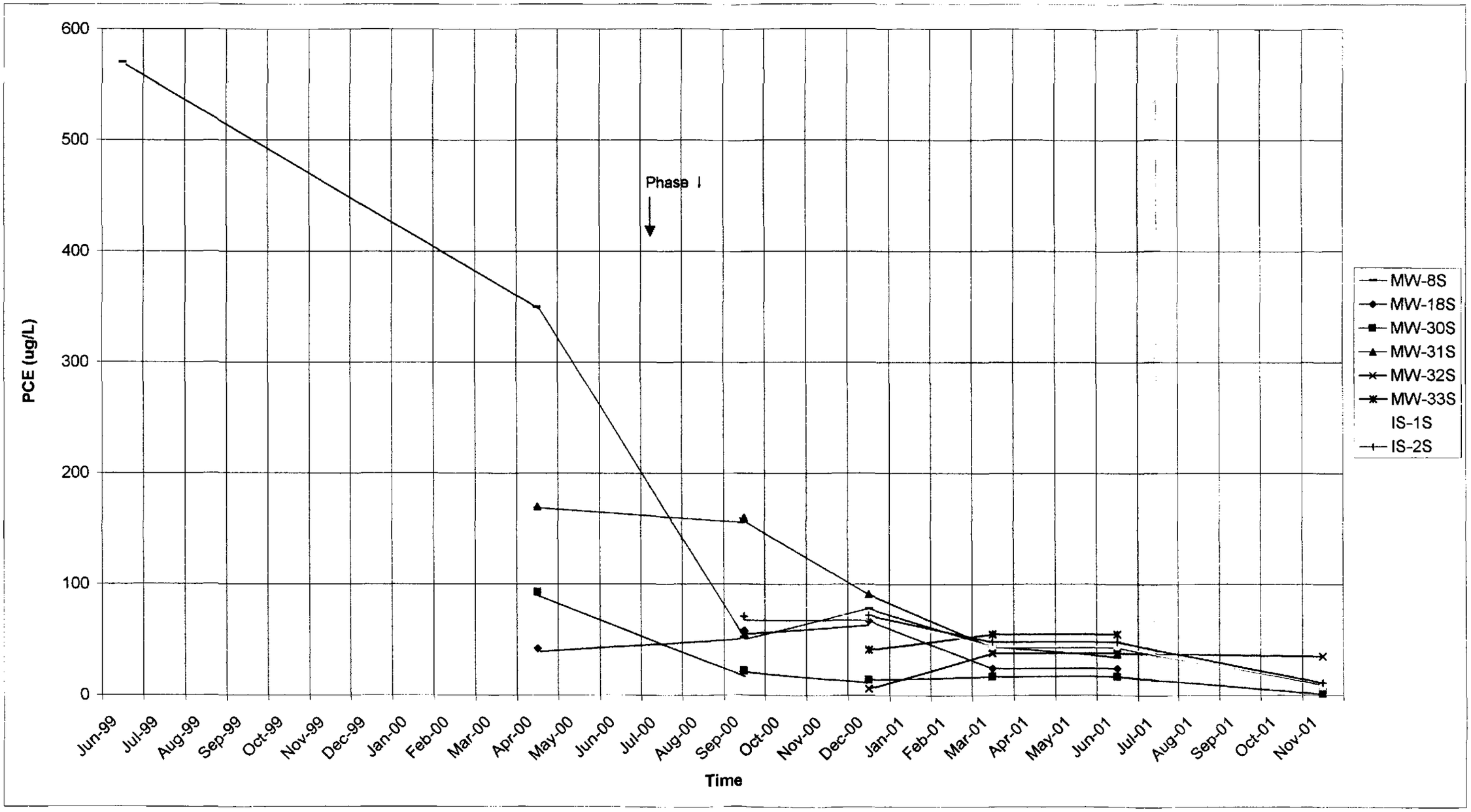


FIGURE 4 - 12
PCE IN SOUTHERN PLUME BEDROCK WELLS
IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

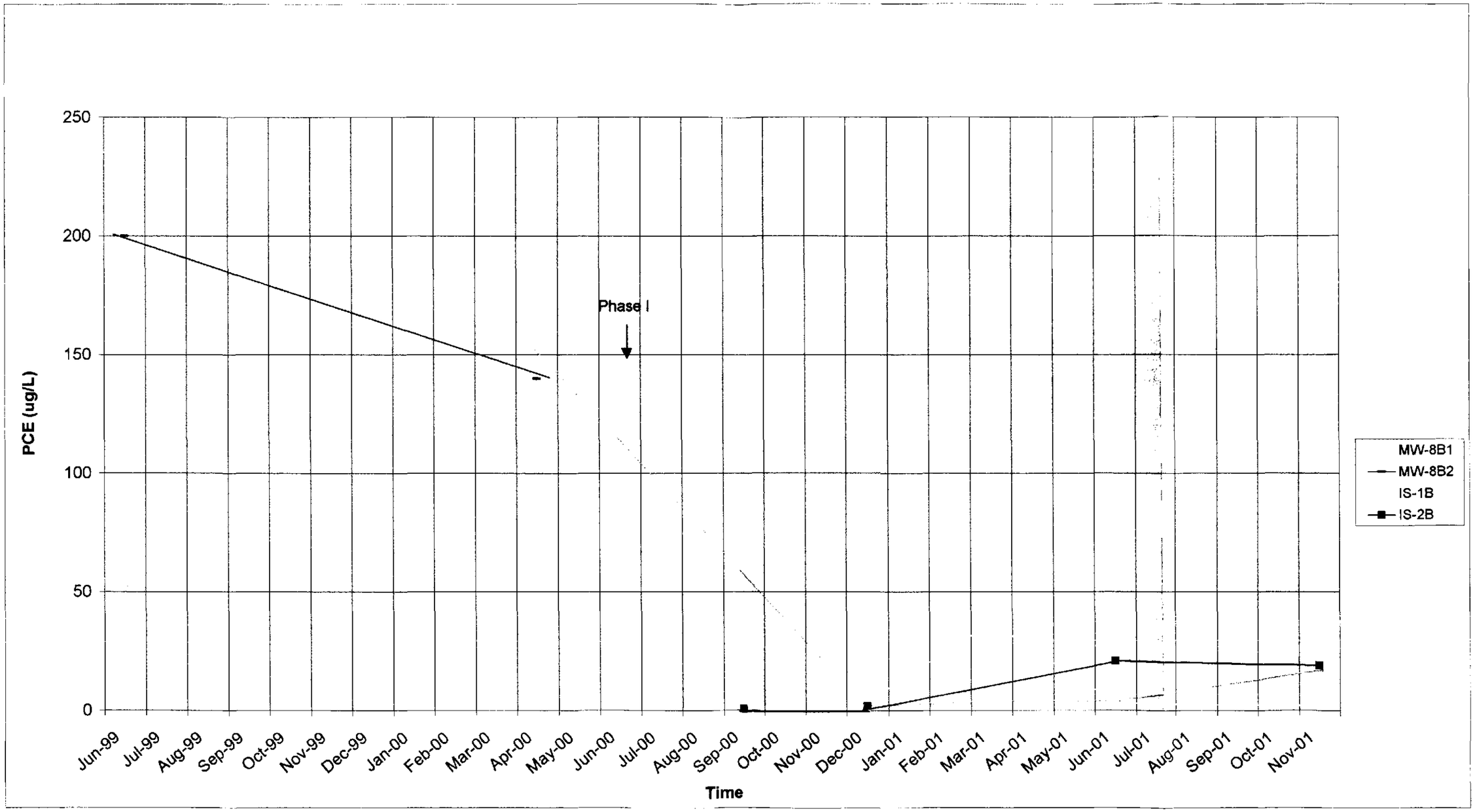


FIGURE 4 - 13
PCE IN SOUTHERN PLUME RECOVERY WELLS
IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE

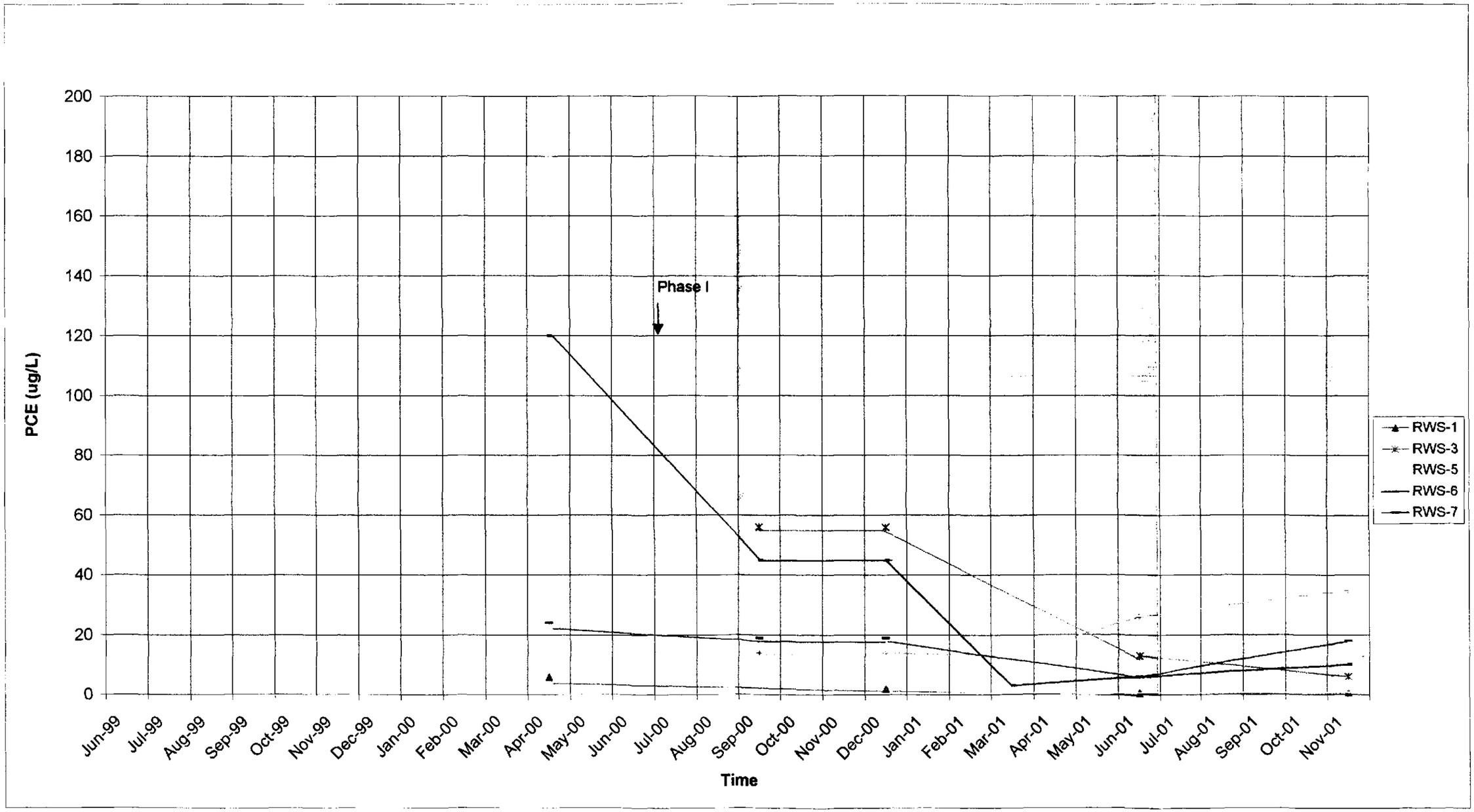


FIGURE 4 - 14
GROUNDWATER LEVEL TRENDS IN
SELECT SOUTHERN PLUME WELLS
IN-SITU OXIDATION TREATABILITY STUDY
EASTERN SURPLUS COMPANY SITE
MEDDYBEMPS, MAINE